ISSN 0704-3716

Canadian Translation of Fisheries and Aquatic Sciences

No. 5131

The Norwegian fillet industry - Thoughts regarding the technology of the future

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Original title: Norsk Filetindustri -tanker omkring framtidens teknologi

In: Fiskeriteknologisk Forskningsinst. Rapp., Prosjektnummer 663.3-6D, 82 p., 1979. FTFI, Stakkevollv. 23, Postboks 677, 9001 Tromso, Norway

Original language: Norwegian

Available from:
Canada Institute for Scientific and Technical Information
National Research Council
Ottawa, Ontario, Canada K1A 0S2

1985

142 typescript pages

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LIBRARY IDENTIFICATION – FICHE SIGNALÉTIQUE

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Translated from - Traduction de NORWEGIAN	Into - En ENGLISH

Author - Auteur
Age Haugslett

Title in English or French – Titre anglais ou français
The Norwegian Fillet Industry - Thoughts regarding the technology of the future

Title in foreign language (Transliterate foreign chara[illegible]
Titre en langue étrangère (Transcrire en caractères romains)
Norsk Filetindustri -tanker omkring framtidens teknologi

Reference in foreign language (Name of book or publication) in full, transliterate foreign characters.
Référence en langue étrangère (Nom du livre ou publication), au complet, transcrire en caractères romains.
Fiskeriteknologisk Forskningsinstitutt Rapport, Prosjektnummer 663.3 - 6D

Reference in English or French – Référence en anglais ou français
Institute for Research into Fisheries Technology Report, Project no. 663.3 - 6D

Publisher - Éditeur	DATE OF PUBLICATION DATE DE PUBLICATION			Page Numbers in original Numéros des pages dans l'original
FtFi				82
Place of Publication Lieu de publication	Year Année	Volume	Issue No. Numéro	Number of typed pages Nombre de pages dactylographiées
Tromsø, Norway	79			142

Requesting Department
Ministère-Client DFC

Translation Bureau No.
Notre dossier nº 1655848

Branch or Division
Direction ou Division SIPD

Translation (Initials)
Traducteur (Initiales) JPC

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Your Number
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Date of Request
Date de la demande 10.12.84

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SEC 5-111 (Rev. 82/11)

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MULTILINGUAL SERVICES DIVISION — DIVISION DES SERVICES MULTILINGUES

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Client's No.—N° du client	Department — Ministère DFO	Division/Branch — Division/Direction SIPB	City — Ville
Bureau No.—N° du bureau 1655848	Language — Langue Norwegian	Translator (Initials) — Traducteur (Initiales) JPC	

THE NORWEGIAN FILLET INDUSTRY

Thoughts regarding the technology of the future

by

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Product Refining Section
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SEC 5-25 (Rev. 82/11)

Canada

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(v) FOREWORD

The background material for this report was presented in and earlier report entitled "The Norwegian Fillet Industry - Possibilities for Improvement of Production Techniques and of the Physical Workplace Environment".

The above report would be far too comprehensive for use in the consideration only of the proposals for technical solutions.

We feel that it is extremely important that the proposals be brought into the open, and the present report was written for that purpose.

The intention of the report is to encourage a wider discussion concerning the development of a variety of systems related to production techniques within the fish-processing industry.

The proposals for technical solutions were prepared, for the most part, by Steinar Eliassen, Georg Gundersen, and the undersigned. Director Egil Folkvard from HARTMARK - IRAS was responsible for drafting Chapter 14. Drafting support was provided by Jan Andreassen.

Thanks are hereby extended to all those who contributed to the report.

Åge Haugslett

(vii) SUMMARY

Improved utilization of the raw material is possible in most existing operations, especially in the form of higher fillet yields. This would also strengthen the economic base of the operation concerned. The delivery of fish with the head attached will be an important positive factor in increasing fillet yields, and also, the head itself represents a resource which should be utilized.

The technical equipment used in transport, unloading, washing, stacking, etc., are presently being developed further. The result should be an improved working environment as well as an increase in plant capacity.

A night-deposit capability (night-safe) can also improve the working environment at the receiving area and also increase the handling capacity of the receiving area. A variety of night-safe designs are proposed.

Fish-gutting machines, fish-cleaning lines (of workers), fish-cleaning machines, and an improved system for washing / draining, sorting, and weighing will all serve to increase capacity in the receiving of raw fish material, provide a better work environment, and lead to more accurate accounting and to improved raw material quality. Proposals are presented for a fish-cleaning system capable of handling washing / draining, size-sorting, as well as weighing operations.

The sorting system (length sorting) and weighing system will serve to increase the capacity and improve the working environment when

combined with a 10% quality control test and receiving from the trawler catch. Proposals are also presented for a system involving the 10% test.

The sorting system located prior to the filleting line will increase fillet yields considerably. Continuous monitoring of the yield from the filleting line can also contribute to an increase in fillet yield. The system for yield monitoring would be based on more or less automatic weighing and utilization of computerized procedures. Proposals for such a system are herein presented.

Use of various new storage on both on ship and on land was discussed. A preliminary conclusion is that use of containers holding an ice-seawater mixture can be feasible (CSW containers). In cases where containers are used on-board the trawlers, problems will arise with respect to the 10% test. One way of solving this problem is by establishing the catch quality prior to the placement of the containers in the raw material storage. The determination of accounts payable will then take place when the catch is taken to the production installation.

The design and location of the raw-material storage facility is critical if it is to provide the best possible capacity and material flow.

(viii) The filleting line could be made more effective if head / earbone removal, cutting up, and skinning were made into an integrated procedure requiring only one operator. The supply rate to this operator should not be determined for capacity reasons alone, but also with reference to quality of the working environment and fillet yields. Proposals for the filleting line are presented.

Cleaning and portioning of the filets are difficult to mechanize. It is important for the operators in the filleting room to be aware of the use the raw material will be put to, and that they also be conscious of quality control. In the filetting room, there is a great need for work spaces designed from an ergonomics point of view. Portioning (weighing) and packaging of the fillets should be mechanizable, and some possible methods are discussed.

Keeping the raw fillet material refrigerated between the production units can also be beneficial both from a quality, as well as an economical point of view. Proposals are presented on the design of such a refrigerated storage system, for potential use both between the cutting and filleting rooms, as well as between the filleting room and the freeze-packing section.

Loading and unloading from horizontal freezer chests should be mechanized, primarily to improve the work environment, but this could also enable increased capacities to be attained. Proposals are presented for systems to solve this problem. the proposals cover unloading operations in the filleting room, transport to the freezer chest (through refrigerated interim storage facilities), loading and unloading of the freezer chest, removal of frozen material, crating, and placing onto pallets. A freezing system which does not use trays would be most profitable because of increased freezing capacity and reduced handling.

It should be made routine that the heads and backbone (or fin bone, as the case may be) be used for fish pulp. For quality-related reasons, it is important that raw materials destined for fish-pulp be stored in refrigerated bins. Criteria should be drawn up regarding the quality and functional properties of fish pulp produced from various raw materials. Equipment for fish pulp production is discussed.

The production process for animal feeds is often unpleasant from a working environment point of view. This process should be upgraded for this reason, and also from an efficiency point of view. The use of vertical slab-freezers equipped with mechanized loading gear is one means of achieving both an improved working environment and greater efficiency.

Problems associated with conventional production (salt fish / dried fish) are discussed. Proposals are put forward for the solution of particular problems. One of these proposals is that all size-sorting take place prior to splitting / hanging, through the use of sorting personnel. Such a step would, among other things, result in the grading / sorting process for the finished product being considerably simplified.

(1)

1. INTRODUCTION

Today, in the latter part of the winter of 1980, the fishing industry is in the grip of a crisis. The scope of this crisis is open to some debate and will not be discussed here. One can assume that it will lead to a certain amount of reconstruction and structural modifications within the industry, in both the fleet and the processing sectors.

A few years ago, there were usually adequate supplies of raw material, and most of the operations were operating at a profit. An important reason for this was that these operations had large production volumes, and therefore the utilization of the raw material did not constitute a limiting factor for profitability. According to the labour agreement, only 3 days notice was required before short-term layoffs and 14 days for long-period layoffs. Prior to this, there was easy access to seasonal labour. This was, and still is, an important factor in keeping costs associated with salaries as low as possible.

Today the situation is quite different. Raw materials now are in rather short supply and it is possible that, under the new Working Conditions Law, 14 days notice would also be required for short-term layoffs. This will make short-term layoffs impossible. People are, for the most part, interested in steady employment and it is difficult now to find any "seasonal workers".

Emanating from this realization that the situation today is considerably more difficult than 2 - 3 years ago, it becomes more important that these operations look around for suitable operational measures capable of maintaining/ re-establishing a sound economic basis in the industry.

In order to be able to say something about operational measures, one must first take a look at how costs are distributed. The numbers shown below have been taken from the fillet industry:

Raw material - packaging:	56 - 60%
Labour (salaries):	20 - 22%
Indirect costs:	18 - 20%
Profit:	0 - 4%
Production value:	100 - 100%

Source : (1)

From the above figures one can see that raw-material costs constitute over 50% of the total production value. By utilizing raw material to the optimum degree, i.e. producing the highest finished product value, the raw-material costs would thus be effectively lowered (see Figure 1.1 for fillet versus minced fish / animal feed production).

Workers' salaries would be effectively reduced through rationalization, i.e. mechanization / automation. However, the direct capital costs would thus increase. Therefore, it is necessary to find the optimum level for labour-reducing investment in each individual operation. In carrying out mechanization / automation procedures, a stipulation must be made that the work environment must not be compromised but, rather, that it be improved.

The indirect costs can also be reduced, for instance, through reducing somewhat the large over-capacity existing in the production lines. However, this is primarily related to the evening-out of the raw-material flow.

(3) As examples of the various operational measures that can be mentioned at this time, we present the following:

- Improved exploitation of raw material, i.e. more fillets at the expense of animal feed and fish pulp; more fish pulp at the expense of animal feed; and also the utilization of the entire fish.

  In order to enable the production of more fish-pulp, the following conditions must be satisfied:

- A market must exist
- Production specifications must be drawn up for various quality levels of fish-pulp
- A technology must be found to enable production of fish-pulp of a satisfactory quality, corresponding to specifications of the various raw-material types
- A price must be achieved which provides a suitable return

  In order to put the whole matter "in focus", one can say that the fish processing industry has a duty to make optimal use of the raw material involved. This is both for its own survival, as well as to be able to pay a decent price for the raw material, so that the fishing vessels can also operate profitably.

- Look into opportunities involving other fish types / raw material types than the traditional, such as rose-fish, blue halibut, shellfish, octopus, big-mouthed flounder, etc.

- Purchase raw material from foreign fishing vessels (proposed by Per M. Arnstad)
- Improved training / education of employees in the industry
- Take steps to even-out the supply of raw materials
- Local and regional cooperation between the various operations insofar as investments, purchasing, insurance, raw materials, further processing, market research, transport, etc. are concerned
- Processing to a greater extent, for instance, fish-cakes, fish-sticks, fish-balls, etc.
- Develop new types of products for local and other consumers (markets)
- Develop and put into use new machinery and production equipment; raise the technological standards
- Adopt flexible production plans so that production can be rapidly shifted to other types of product. This is dependent on the nature of the market and on the supply of raw material

The two latter points may be viewed as technological concepts and will be the main subject area of this report.

We will look closer at some of the operational measures listed above.

(4) 1.1 Utilization of raw material

In order to achieve a higher utilization of the raw materials, it is essential that this raw material be of the highest possible quality.

The conditions of the raw material when it arrives at the production stage is dependent on the condition of the fish when it is taken from the sea, as well as its subsequent handling and treatment on board the vessel and on land.

The condition the fish is in when it is caught is something one has very little control over. It is important, however, that full nets not remain unemptied for too long, and that the fish be gutted and handled properly on board. In order to ensure this, there must be a law which stipulates that the price paid for fish must be based on its quality. The use of containers (ice / water mixture) can also aid in raising the quality standard of the raw material.

The handling of the raw material during transport and storage on land, and during the production process is the responsibility of the fish processing plant, and it is here that an internal education and strict production control program could be strongly recommended. A good employee education program could eventually make it unneccessary to institute a strict production control plan.

In Figure 1.2 and 1.3 are presented some economic benefits accruing from an improved utilization of the raw material. In the examples shown in these two fugures, an increase in processing value added of 3.05 - 1.70 = 1.34 kroner per kilogram of raw material, (processing value added = finished product price - raw material price).

(5) 1.1.1 Fillet yields

There is about 85% meat in a cleaned fish (cod) with the head removed, the remainder being skin and bones. In the production of fillets, the normal meat yield is approximately 55% (50 - 52% fillets and 3 - 5% fish pulp).

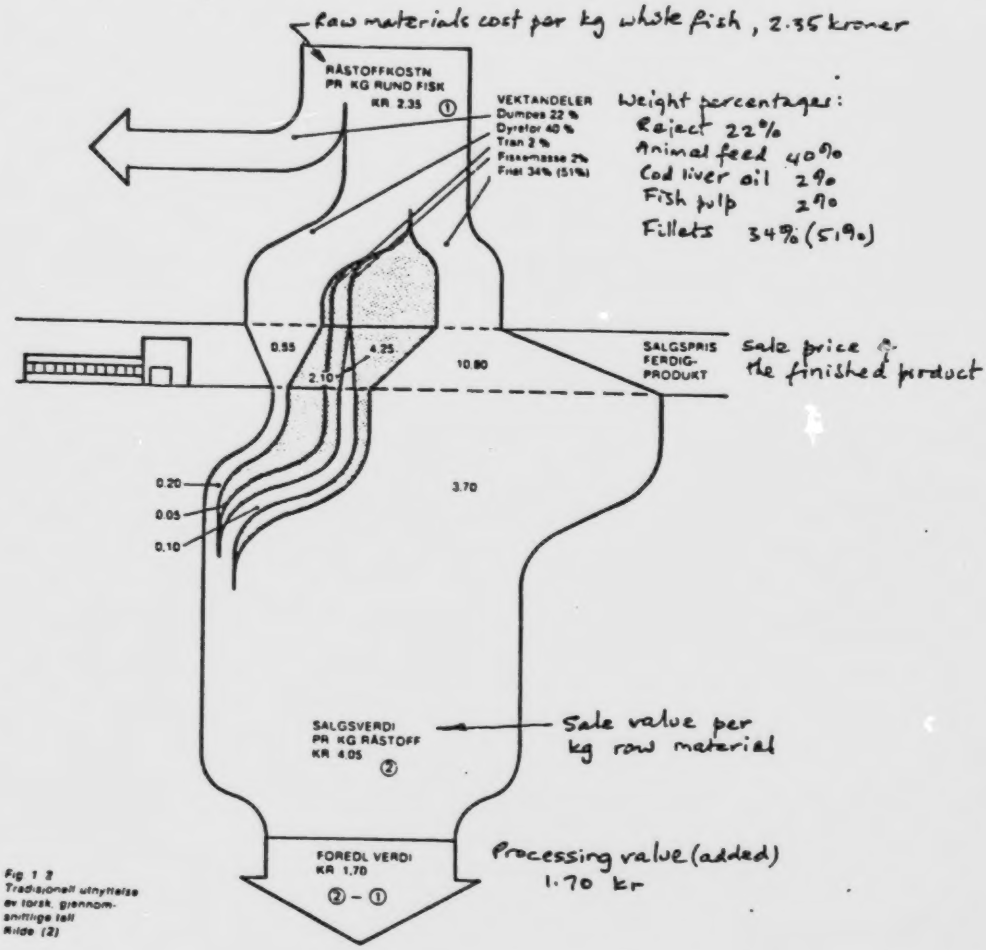

Fig 1 2
Tradisjonell utnyttelse
av torsk, gjennom-
snittlige tall
Kilde (2)

Figure 1.2 Traditional utilization of cod, average figures. SOURCE:(2)

(For translation of labels see Fig. 1.2)

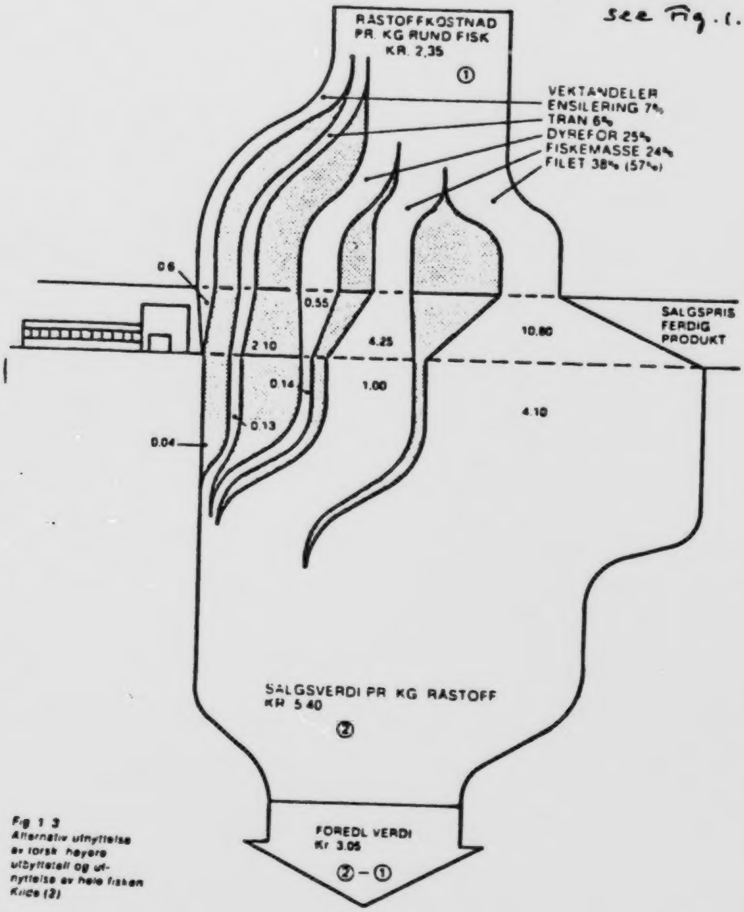

Fig 1 3
Alternativ utnyttelse av torsk høyere utbyttetall og utnyttelse av hele fisken
Kilde (2)

Figure 1.3 Alternative utilization of cod, showing higher yield figures and utilization of the entire fish. SOURCE (2)

In practice, it should be possible to achieve a fillet yield of about 54 - 55% (cod). Large-scale tests have shown that it is possible to achieve an up to 60% fillet yield.

In Figure 1.4 some yield figures are presented. These figures were achieved during an experimental production run involving approx. 2000 kg cod.

As is seen in the table, losses in the machine are not included, and it is to be expected that there will always be bits and pieces in the wastewater from the machines. Thus it is only the figure in the middle column that is actually weighed. The numbers in the first and third columns must be computed afterward. At the end, the total losses and the waste are added (1.8%). A total yield of 61% is obviously quite high, but taking a figure of 54 - 55% as the goal appears to be realistic. A yield percentage of 50% or less is taken to be abnormally low.

(7) Each percent increase in fillet yield, at the expense of animal feed, will increase the processing value added by approx. 10 øre (1 øre = 0.1 kr) for each kg of raw material. For an operation with approx. 3 million kg raw material per year throughput, this corresponds to about $3 \times 10^6 \times 0.1 = 300{,}000$ kr.

An important contribution to the increasing of fillet yields could be made by receiving fish with the heads still attached. In most other countries, all fish are delivered with heads attached, and here in Norway, the present delivery mode occurs following exemption from Article 7 of the Fresh Fish Regulation. Experiments have demonstrated that it is possible to increase fillet yields by approx. 1 - 2% of the cleaned, headless weight, if only the head were left on the fish when it is brought to be processed. This would provide for better cut surfaces, and losses due to shredded tissue and oxidized / tainted neck cuts would be avoided. Furthermore, the head could be used either for fish pulp, dried fish, fish-meal production, or for animal feed. If the head is to be used for fish pulp, the gills may have to be removed. This requires to be examined in more detail.

It will cost something to increase the fillet yield and so Figure 1.5 shows how conditions involving total revenues and total variable costs can vary as functions of the yield percentage.

1.2 Training / Education

The access to further education and occupational training should be increased and expanded in order to strengthen the industry both from an economic / administrative, as well as a technical, point of view. The industry should provide subsidies and incentives to young people who enroll in an approved industry-related training course. A type of occupational certification must be created for fishery-industrial workers. This would both strengthen the industry and increase the social status of the professional.

The operations must also, to a large degree, institute internal training programs, and where circumstances permit, several operations (firms) can combine their training programs. By supplying a basic occupational training, the operations can achieve improved yields, higher product quality, as well as reduced occupational illnesses and mishaps among their employees. There is a saying that one capable instructor can substitute for several control personnel.

1.3 Evening out of raw material flow

One of the major problems for the industry has been, and still is, the very large variations in raw material flow. This has been a contributing factor to:

- Investment in much too great a production capacity compared to the average year's production
- Extensive use of short-term lay offs and of seasonal labour, a factor that has led to unstable working conditions in the industry
- Relatively poor yields due to the fact that the primary objective is to pass the most fish through the plant at peak periods
- (8) Too little emphasis on a "correct" utilization of the raw material in periods of plentiful supply, i.e. too little production of those products that provide the highest economic return
- Too much "stretching" of the raw material during periods of low raw material supply, i.e. too high labour costs per kg raw material

Solving the problem of fluctuations in the raw material base is no easy matter. One way to get a comprehensive picture is to consider a "hypothetical" fishing station in an outlying district as a combined unit, comprising both vessel and processing operations. Whenever there are periods of abundant fish supplies, everyone including fishermen, fish processing staff, and others involved in the fishing industry in the area, are expected to pitch in fully and willingly work shifts if necessary. In this manner, they may do a full year's work in a shorter time than normal. During slack periods in the fishery, both fishermen and fishery workers take time off. This is, in other words, a very flexible system with respect to working time and time off, and both are taken in large "doses".

There are, naturally, many who would not agree with such a system and this view is understandable. The only alternative, however, is to have a means of interim storage for raw materials during periods of abundant supply for processing during periods of low supplies. Possible formats for interim storage are freezing the fish whole (double freezing), live fish storage in seine-nets and transport in a live condition, and single freezing. In addition, in evening-out the raw material supply, it is possible to transport the raw material from one region to another, but there must be close co-ordination between these regions.

1.3.1 Whole-fish freezing / thawing (double freezing)

Some firms have, for some years, made use of whole-frozen raw materials, frozen during periods of abundant supply and processed during those of low supply. The main problems are fluid losses during thawing, extra labour input, and loss of yields in the filleting process. Together these contribute to reducing the overall revenues by about 50%. The thawing losses are, to a disproportionate degreee, the heaviest loss factor, with 10% thawing losses resulting in an approx. 50% reduction in the overall revenues. Raw material that is whole-frozen is first cleaned and the head is removed. The process: whole-freezing, thawing, processing, and freezing is known as double freezing.

In order to limit weight losses, polyphosphate has been used. Since the initial freezing is done only on first-class, completely fresh fish, the quality of double-frozen fillets will be completely satisfactory. In the case of cod and haddock, freezing must be carried out prior to the onset of rigor mortis. These raw materials must be stored for at least 8 weeks (so that rigor mortis can disappear) prior to thawing. This is to aid in the cutting process. In order to freeze the fish prior to the onset of rigor mortis, the freezing operation must take place onboard the freezer-trawlers, or at installations that receive very fresh fish. Onboard the trawlers, vertical plate freezers are used for freezing, and on land, tunnels or vertical plate freezers are used. Nowadays, there are very few installations using vertical plate freezers. However, those installations which make use of such equipment for the production of animal feed cubes could also use them for whole-fish freezing.

There is a definite need to know more about how, and to what extent, do the nature and physical properties of the fish at freezing influence thawing losses and the quality of the finished product.

(9) Thawing was previously done using water. Nowadays, a number of thawing installations have been built, in which thawing is carried out using "warm", humid air. Other thawing techniques also exist. There is a need for a closer investigation into the various techniques. It can be hoped that after a while, one would have identified the best thawing technique(s), and how the optimal process should be carried out. Optimal in this case is expressed in terms of liquid loss, quality, capacity, and energy consumption. Whenever the process has been identified and set up, then it can be "programmed" into an automatic control system for each thawing installation. This is in order

to avoid manual tending of the installations.

Transport into / out of a thawing installation can be made as mechanized and automated as one wishes. The only question here is how much is to be invested.

Because of raw material quality considerations, increased use of whole-frozen material will lead to a larger number of freezer-trawlers.

It will also be necessary that the processing plants exercise some management control over the trawlers. In this way the plant could determine the relative amounts of fresh and frozen raw material that will be delivered. Some operations, receiving fish from the coastal fishing fleet, are located so close to the fishing grounds that they can carry out their own whole-freezing, and thus can retain good control over their situation. Some of the periods of low raw material supply occur annually, and the plants can take operational measures against these periods through the storage of frozen raw material.

1.3.2 Live storage of raw material

Live storage is used in connection with the seith (pollack) fishery which takes place in the summer and fall. There are problems involving high mortality and quality deterioration when long-period storage in seine-nets is practiced. These problems must therefore be overcome.

In the future, one can imagine storing live fish by shutting of the mouth of fjord arms. At the Institute for Technical Cybernetics, National Technical University, Trondheim, a number of research projects are being carried out on the feeding, management, and re-catch of fish placed in fjord arms. It is very conceivable that considerable advances will be made in aquaculture, insofar as the traditional fish-types such as cod and pollack are concerned.

1.4 Technology

If one compares the technical developments taking place in the fish processing industry to similar developments in the fishing fleet over the past 10 years, it is obvious that developments in the fish processing industry have come at a much slower pace.

In other words, there is room for considerable technical innovation in the fish processing industry, and this will constitute a very important factor in the operational measures outlined earlier. However, detailed evaluations must be made into the following aspects related to each technological advance before the idea can be put into practice:

- Capacity increase
- Improved working environment, both from a physical and paychological point of view
- Upgrading of the social esteem of fish industry work
- (10) Flexible production schedules
- More even production effort
- Higher profits for the plants

The remainder of this report represents a discussion of possibilities for technological improvements in the fish processing industry.

In Figure 1.6 is presented a flow-diagram for a typical fish processing plant. The various units are labelled from 2 to 13, corresponding to the chapters in which these units are discussed. The 12 units present are shown below:

2. The transport system, unloading, washing and storage of crates, containers, and trays. Ice production, ice transport, and loading the ice into the containers and vessels.
3. Receiving of whole-frozen fish, ("night-safe").
4. Gutting, cleaning, sorting, washing, and weighing.
5. Receiving of cleaned fish, determination of the catch size. Whole-freezing / thawing.
6. Raw material storage.
7. Filleting lines with supply from the raw materials storage facility. Size sorting, weighing, and yield control.
8. Production of fish pulp.
9. Production of animal feed, including freezing.
10. Maintaining refrigerated conditions between production units.
11. Cutting up / assignment, portioning, and packaging of fillets.
12. Freezing section, with freezer-storage unit.
13. Conventional production at the filleting installation.

The proposals and recommendations within each unit are sub-divided into options 1,2, and 3. Option 1 represents approximately

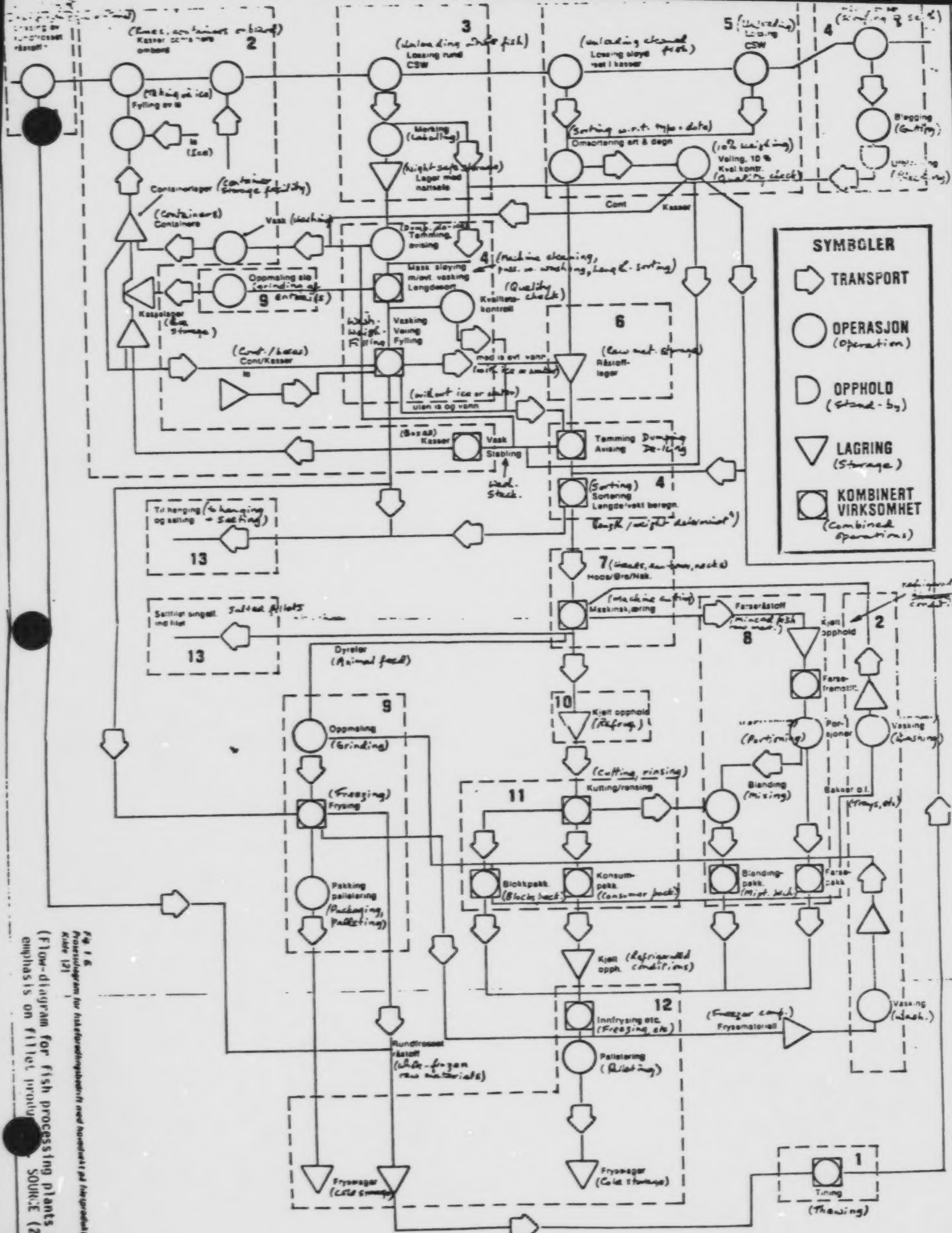

Fig 1.6
Prosessdiagram for fiskeforedlingsbedrift med hovedvekt på fileproduksjon.
Kilde [2]

(Flow-diagram for fish processing plants with emphasis on fillet produ SOURCE (2))

the technological level existing today. Option 2 lies at a somewhat higher level, while Option 3 represents the presumed situation 1 - 10 years into the future. These options are not necessarily presented for all units. It is naturally a logical possibility that parts of the various options can be combined.

In connection with the recommendations for the various system solutions, no cost estimates were included. These, together with estimates for manpower and capacity, must be carried out when the various proposals are evaluated against each other, and also against other proposals. This report also does not attempt any comment on savings on water or energy consumption.

(11)

2. TRANSPORT SYSTEM, UNLOADING, WASHING, AND STORAGE OF CRATES, CONTAINERS, AND TRAYS. ICE PRODUCTION, TRANSPORT, AND LOADING INTO THE CONTAINERS AND VESSELS

2.1 Transport system

2.1.1 Transport of whole fish

For storage and transport of whole fish, whether cleaned or not, crates, containers, and bins are the methods most in use today. However, in time there will probably be a drift toward increased use of containers and tubs, see Chap. 5.

On the plant site, gas-driven fork-lift trucks are generally used nowadays for the transport of crate pallets and containers. In the future, there is a possibility of a forced switch to electric fork-lifts for all inside transport, for air-pollution control reasons. For this reason no development is proceeding into motors or cleaning devices which emit dangerous exhaust gases.

Whole fish may be also transported internally via conveyor belts and mechanical carriers. The latter is commonly used for taking fish and fish parts up out of rinsing bins and up to higher levels. Elevators are also commonly used for transporting fish from floor to floor. Insofar as downward transport is concerned, use of chutes / slideways can be feasible.

Within a "few" years it could become possible to transport containers by powered roller-bed laneways, or along overhead trackways mounted under the ceiling. In other industries, such overhead trackways are very common. Such a transport system would be especially suited for transport of empty containers.

Transport of crates and containers from the loading area to the deck will continue to be carried out in conventional ways, i.e. by cranes, which has proven to be a flexible means of unloading / loading. Other equipment systems are under development for use in unloading crates. A sketch of one such system is shown in Figure 2.1.

For larger fishing vessels, the use of side ports and fork-lifts is being contemplated for loading / unloading. The use of powered roller-bed laneways may also be contemplated in cases where the vessel is equipped with side-ports.

As mentioned in Chap. 5, consideration may be given in the future to transport of fish from the boat to the processing plant in water-filled conduits in cases where fish are stored on board in tanks.

2.1.2 Transport of cut-up fish, fillets, etc.

Such transport can occur in a variety of ways, of which the most commonly used are:

- In trays on fork-lift trucks / trolleys
- In trays on roller-bed ramps
- Simply on conveyor belts
- With the aid of gravity via chutes / slides, for downward transport between floors
- (12) In water; this applies for fish parts destined for use as animal feed

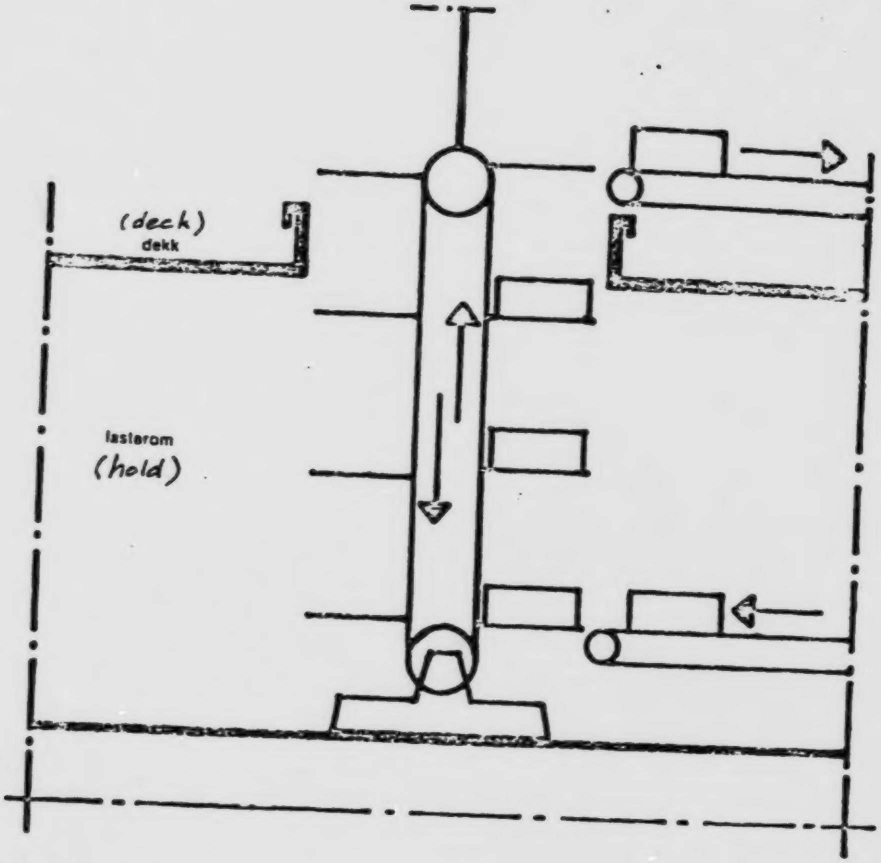

Fig. 2. 1
Transportsystem for lossing av kasser fra fartøy.

Figure 2.1 Transport system for unloading boxes from the vessel.

The last-mentioned technique is not commonly used, and when used, is in connection with animal feed. Like in the case of containers, one can contemplate the future transport of containers (trays) under the ceiling.

2.2 Dumping (emptying) of crates and containers

At present, crate emptying is generally carried out manually, a rather miserable and tedious chore. Also used are stationary mechanical container dumpers, into which the container is placed by means of a fork-lift. Automatic crate dumpers have been developed, and also possible are automatic stationary container dumpers, into which containers are "fed" using roller-bed laneways.

Combined crate / container dumpers are also a possibility.

(13) 2.3 Washing of crates, containers, and trays

There exist today completely useable automatic washers for crates, and so automatic means for washing containers ought to be developed. One can also contemplate the development of machines capable of washing both crates and containers. Manual washing of containers would not be a very attractive job. All washing should therefore be made automatic, at least with regard to insertion and removal. By the exit of the washing machine for crates, one can contemplate placing an automatic stacker. Such an automatic stacker would be able to place crates onto pallets in specified numbers. When the crate pallet is full, it can then be pushed onto a roller-bed conveyor, for example, for transport to the empty container storage area. Even the transport to the empty storage area can also be carried out using the principles outlined in 2.1.1.

Washing of trays should, for reasons of capacity and working environment improvement, be carried out using machines located at a central station. The transport pathway for trays should, at regular intervals, be made to pass through such a wash-station. After leaving the central wash-station, the trays can be collected (stored) prior to re-entering the transport chain. The capability should exist for rinsing the trays at the various work-stations when they are emptied and re-used inside the production chain.

The washing machines should be located in "wet areas" and areas where as little dust as possible is generated.

2.4 The empty container storage area

It is common practice to store empty containers on the dock, see Fig. 2.2.. This is not particularly desirable from the point of view of dock-space, order and aesthetic appearance, efficiency, wear and tear, and breakage of the empty containers. This is especially the case when there is snow on the ground. A storage shed for storing empties can help somewhat in this regard. The storage area should naturally be located within the physical structure of the plant, i.e. with regard to transport pathways, etc.

2.5 Ice production and filling

Equipment for ice production is at present of a high technical standard. Relatively well-suited equipment (screw-conveyors, belts, pipelines, and like) for transporting ice around the plant and onboard vessels are presently available. It is nevertheless possible that some effort may profitably be applied to developing improved equipment for ice transport.

Since containers filled with an ice / water mixture are becoming more and more in use onboard trawlers and other vessels, a large portion of the ice will be loaded into the containers when these are taken onboard the vessel. Special equipment must be developed for this operation since such equipment presently is not available. The transport pathway for the containers from storage area to vessel must be made to pass through a central filling station. Even when the ice has been placed in the containers, the ship must still take on an extra portion for topping up when the containers are filled with fish and water. This after-filling with ice is necessary in order to keep temperatures low throughout the containers. Suitable equipment must be developed for use onboard the vessels to carry out this after-filling in the simplest way possible.

(15)

3. RECEIVING OF ROUND FISH, "NIGHT-SAFE".

3.1 Delivery of round fish

In the Fresh Fish Regulations, Art. 7, it is staed that:

> "Fish which is to be rendered in a fresh or frozen condition (i.e. for fresh use) shall be cleaned as soon as possible after bleeding, preferrably within 1 hour after being caught. In weather warmer than +5°C, fish must not be kept uncleaned for more than 4 hours".

Insofar as the delivery of round fish is concerned, Article 7 means that cleaning must occur immediately after unloading, and preferrably directly after the fish reaches the dock. A large portion of the delivery takes place after the normal working day in the plant has ended. Traditionally, it was the fishermen who looked after cleaning the fish, but it has become more and more common for the plant to be responsible for cleaning, or for finding persons to clean, the fish. This irregular and frequently late delivery can lead to the fact that the fish-cleaners must work an unpleasant work-shift (overtime), and at an accelerated pace. Since round fish can be satisfactorily stored overnight in ice-filled crates inside a refrigerated room, or in ordinary store-rooms in insulated crates packed in ice / seawater mixtures, the working conditions of fish-cleaners will become easier. Receiving capacity will also be larger, since the refrigerated room will act as a buffer. This storage area will hereinafter be referred to as the "night-safe". The storage area can also be used for cleaned fish delivered by the coastal fishery fleet after the working day at the plant has ended.

The above regulation (Law), especially Article 7, can have a hindering effect insofar as the adoption of the night-safe approach is concerned.

3.2 Transport of fish from the fishing grounds to the receiving facility

There are three methods that are presently available for freighting round fish from the fishing grounds to the processing plant. This is under the assumption that the catch will be stored overnight in the night safe. These three methods are:

- The fish are brought in in bins and held in containers, or tank(s), as the case might be, in a water / ice mixture during unloading
- The fish are packed in ice in crates after bleeding
- The fish are placed in containers with an ice / water mixture immediately after gutting. They can bleed out in the containers (CSW Containers)

Of all these methods, the last one is preferable. The fish will undergo an adequate bleeding, rapid chilling, and a gentle handling. The keeping ability of fish stored in containers is at least as good as for fish packed in ice in crates. If the plant has cranes capable of lifting the approx. 1.5 tonnes that the container weighs, then the containers would also be the easiest to handle.

(16) In recent times, a certain amount of research has been carried out on maintaining the fish in tanks holding mechanically cooled seawater (RSW).

For the present, we believe this technique to be not very useful for the coastal fleet, since this fleet is composed, for the most part, of smaller vessels. A structural rationalization of this fleet over to larger vessels can make RSW tanks possible for this fleet as well, but for the moment, it seems that overall profitability is best in the case of smaller vessels.

Similar tanks in land-based installations for the storage of round fish (night-safe) have been put into operation in Iceland, and many represent a viable option in Norway as well. RSW containers have been developed, but at present are not very feasible for the coastal fishing fleet.

3.3 Accounting and settlement of accounts

After being cleaned, the fish are sorted and weighed. These procedures are therefore related to the purchasing transaction of the fish by the plant. With regard to existing regulations, the settlement of accounts must be made immediately after delivery. Because of the night-safe innovation, however, accounting and settlement will be postponed somewhat. Nevertheless, the system in itself would serve to ensure a correct accounting. All equipment used in buying or selling falls under the accuracy specifications and control of the Bureau of Weights andMeasures.

3.4 Design of the night-safe

The storage facility, in which containers and crate pallets will be held, may be set up in various ways. How it is eventually designed will depend on the degree of mechanization and automation desired. The maximum daily delivery amount is specified as the storage capacity. In this is built in a small overcapacity factor, because of simultaneous deposit and withdrawal.

3.4.1 Night-safe, Option 1

In this case, the night-safe is thought of as a standard cold storage room, or as a standard storage facility for containers. Containers, or crate pallets, as the case may be, are marked with the number and name of the vessel and placed in the storage room. A receipt is delivered to the boat indicating the number of units stored. One or two persons from the plant staff must be present during the delivery. They will also be responsible for handing over clean crates / containers and ice. Either a bulletin board or a computerized system may be used to keep record of the storage, but this applies mainly for larger installations. Such records may include:

- The vessel delivering the goods
- The quantity delivered by each vessel
- Time of delivery
- Whether crates or containers are involved
- Location (within the storage-room) of each individual catch

The fish are later taken out of the storage room for cleaning. After being cleaned and washed, the fish are size-sorted (or by type) and weighed. At this stage the calculation of accounts payable and the settlement can be carried out.

(17) 3.4.2. Night-safe, Option 2 (Fig. 3.1 and 3.2)

Since it is desirable to have an improved utilization of the storage-room floor space, a shelving system may be used in order to create several units in a vertical sense. This therefore represents a type of deep-stacking storage room. Figure 3.1 shows how the shelves can be set up. The shelves are arranged in such a way that inbound loading takes place at one end of the storage room, while outbound loading takes place at the other.

Inclined, free-moving, roller-bed tracks at several levels may be used. This arrangement is shown in Fig. 3.2. Units are placed on one end of the roller-bed track and transported to the exit end under the influence of gravity alone. The storage room is designed to resemble a closet with rolling doors at both ends.

In using roller-bed tracks or shelves, the crate pallets and containers must have roughly the same dimensions, since it will take some time before containers completely replace crates onboard fishing vessels.

Service and use of the storage room can be carried out as described in 3.4.1.

(18) 3.4.3 Night-safe, Option 3 (Fig. 3.3)

In the case of this storage facility option, taking delivery after hours could be carried out by some of the plant staff. This pre-supposes that the vessel staff are capable of operating the crane and the computerized equipment. One practical difficulty in such an arrangement is that certified crane operators might be required.

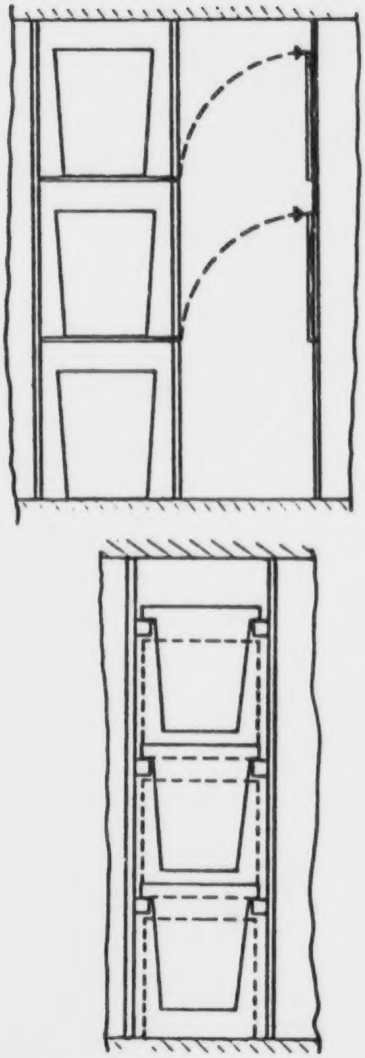

Fig. 3. 1
Reolsystem for dypstabling av containere.

(Shelving system for deep-stacking of containers)

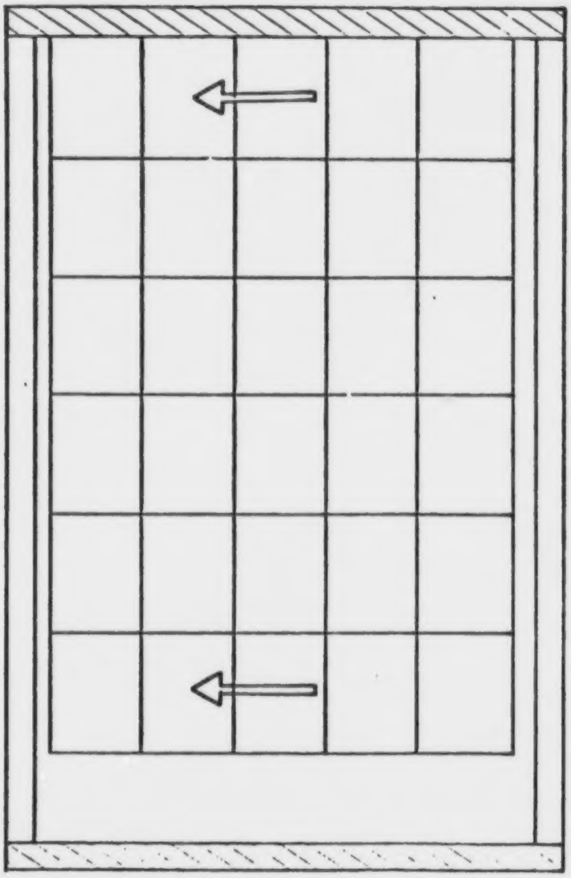

Fig. 3. 2
Nattsafe med skrånende, selvdrevne rullebaner.
(Night-safe with inclined, powered roller-beds)

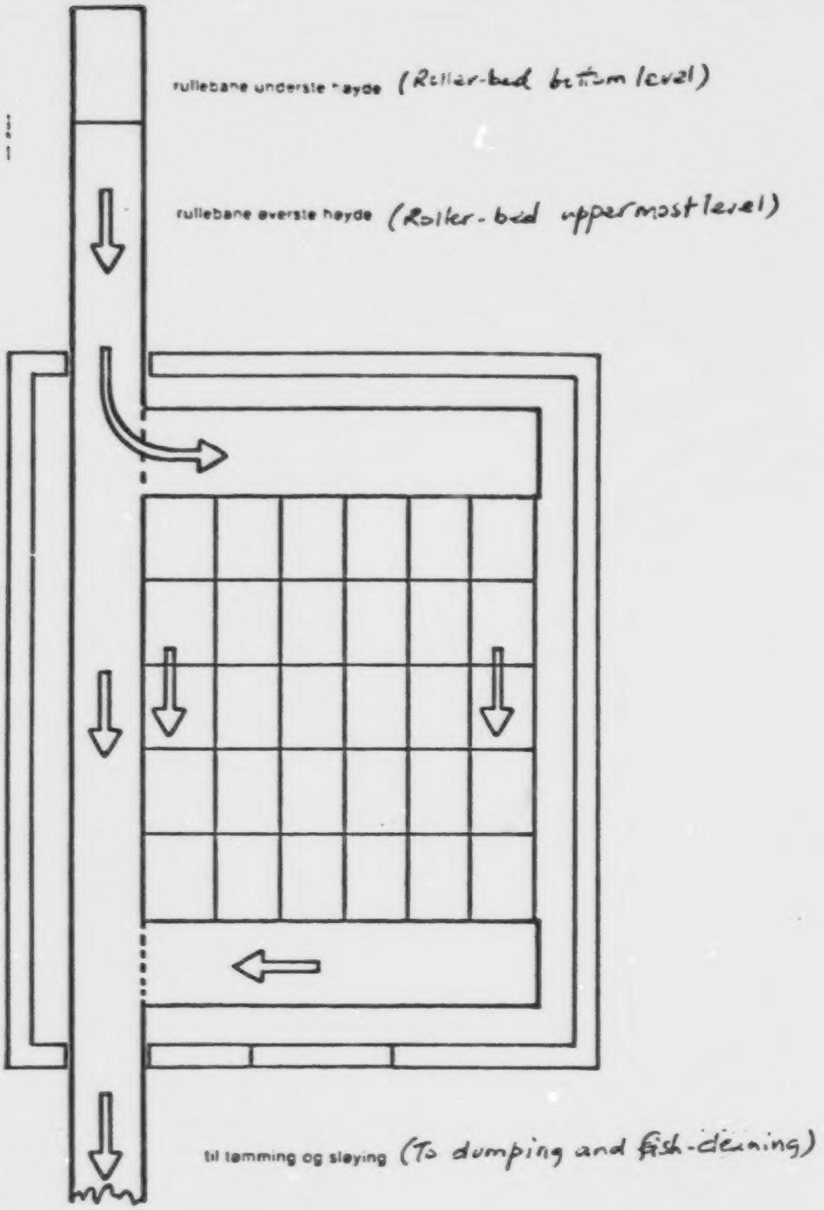
rullebane underste høyde (Roller-bed bottom level)
rullebane øverste høyde (Roller-bed uppermost level)
til tømming og sløying (To dumping and fish-cleaning)

Fig. 3. 3
Nattsafe, helautomatisk drevne og frittløpende, skrånende rullebaner.

Figure 3.3 Night-safe, completely automatic operated and free-flowing inclined roller-beds.

If the ship's own loading / unloading gear can be used then this difficulty would be circumvented, but the smaller boats would not have such equipment.

The storage room is arranged with two levels of inclined, self-powered roller-beds. Transport into and from the storage room is via powered roller beds in the two levels. An automatic dumper must therefore be used which can operate at two different levels. Instead of two powered roller-beds coming out of the storage room, (19) one could use an elevator which would take the containers down from the upper to the lower level, or one could use a fork-lift truck. This type of storage room is designed exclusively for containers, so it is envisaged for relatively far into the future (5 - 10 years).

Use of the storage room. Each boat associated with the installation is given an identification card which is inserted into the automatic receiving (deposit) system. This provides authority to use the crane equipment, to deposit fish inside the storage room, and to receive in turn empty containers and ice. The principle is similar to that used in other connections such as access to buildings, automatic gasoline pumps, and automatic money-changing machines.

Each load brought in from the boat is placed onto one of the "in" roller-beds. This can be done in response to a signal from the computerized system.

The crane operator must input data regarding the contents of the container, fish types, and when the container was filled. A numbered plastic card for attaching to the container then comes out of the computerized system, and the container is then allowed to roll into the storage room.

The plastic card on the container represents a redundant security measure for eliminating incorrect accounting in the case of a possible equipment failure. After all the containers have been delivered, a receipt and control record copy are presented to the fisherman, with a line for each container deposited. A corresponding control copy is put aside for the plant's internal records. In the storage room, the container is deposited in the appropriate place by an automatic guide system.

Withdrawal from the storage room is controlled from the work place of the cleaning machine operators, and may be either direct (i.e. the first container on the line) or selective (i.e. the oldest container with cod, for example).

Before dumping of the container can begin, the attached plastic identification card must be unfastened and inserted into the data input unit. When a shift is made from the catch from one vessel to that from another, the entire cleaning line must be cleared of fish in order to avoid confusion in the calculation of accounts payable. The identification card procedure ensures that this is done.

(20) 4. GUTTING, CLEANING, SORTING, WASHING, AND WEIGHING

4.1 Gutting

Gutting presents a problem for those plants using live pollock as raw material. This can represent the limiting factor in plant capacity. From the point of view of the working environment, this particular operation is not very pleasant.

In some plants, gutting lines have been developed, which have improved the situation considerably. The next step is to develop gutting machines. Feasibility studies have already been initiated into such machines. An ergonomically appropriate and effective feed system, an effective "holding mechanism", and a control system which allows sure positioning and a precise cut represent the most important requirements of such a machine. Whatever gutting machine is eventually developed must also be useable onboard ship as well.

4.2 Cleaning

At present, cleaning out of entrails is carried out both manually and using special machinery. Manual cleaning is carried out using the traditional cleaning tubs. The cleaning crew have a very unpleasant task, and much wastage takes place.

A manual cleaning line equipped with a conveyor / slides and well-designed work stations is presently under development. A "manual" cleaning machine in which the fish is held by the machine and in which the operation is carried out manually with the aid of special air-powered tools is now in the preliminary development stage.

The cleaning machines used today are not all equally pleasant and efficient from the point of view of operator comfort and of the quality of the entrail removal. Machines of the carousel type are characterized by a clumsy feed system in which the fish must be hung inside the machine. In some machines, it is necessary to ensure that all the entrails have been removed.

A cleaning machine (SLM) is now under development which has the following specifications:

- Pleasant design of the operator's working place, feeding must take place without the fish having to be lifted.
- The machine must have a wide useage range and good capacity.
- The machine must be easy to maintain and keep clean.
- The cuts made must be of the correct length and depth.
- Entrails and gills must be efficiently washed out; the head shall remain attached.
- The fish is rinsed clean within the machine.
- The machine must be able to sort fish according to size

(21) 4.3 Sorting, Washing, and Weighing

The traditional way is to size-sort the fish according to weight after cleaning and rinsing. After the weighing has been done, the fish are tipped into washing bins. Following this the fish are packed in ice inside crates, or are held in containers holding an ice / water mixture, and are then placed into the raw material storage facility. If the fish is to be sent directly to the processing area, it is naturally not necessary to use either the ice or the ice/ water mixture.

The weighing system results usually in a high percentage of fish being discarded. In addition both blood and water are included in the weight to some dgreee. Even the weighing itself is not especially precise, as some fish can by-pass the weighing balance or be tipped over. In this way there can be up to one or two fish too many or too little in each weighing. The precise person who is responsible for the weighing system used today is difficult to determine. Both parties to the transaction should in the meantime be very interested in achieving the most precise weight possible.

Even the washing system does not function as well as it should. It is possible that a washing system using a rotor would function much better, but all washing in which the fish has to be held in the water requires frequent water changes, and therefore very high water consumption. Biological and mechanical treatment of the water is perhaps a possibility, so that the water can be used several times. Hosing down the fish with water is perhaps the best means for getting them clean.

A certain amount of improvement to the sorting / weighing system can be achieved through the use of manual sorting, slides, containers, and a central weighing unit which also would register the precise amount of fish in each container (the weight is calibrated with respect to empty containers). An even greater improvement would be obtained using automatic sorting and wieghing systems. By using the SLM system described before, automatic size-sorting is possible.

4.4 Production lines for cleaning, washing, sorting and weighing

From now on it is assumed that the weighing system used will be one that weighs each individual fish. The on-line weighing systems in use today are not accurate enough for this purpose and when such "single-fish weigh scales" are established on the production line, it is under the specification that weigh scales or balances have been developed which satisfy the requirements for accuracy. In place of single fish weighing systems, smaller scales may be used which are capable of weighing up to a certain amount of fish. Such scales shall be referred to from now on as "bulk weigh-scales". In most cases buffer areas must be set up both in front of and behind the weighing balance. In front of these balances there must be a system for dewatering the fish.

It is conceivable that weighing systems would be developed in the future which are based on other principles than those used in weigh scales today.

4.4.1 Cleaning , washing, sorting, and weighing, Option 1 (Fig. 4.1)

This particular system is based on manual cleaning and sorting lines. It assumes that the head is still attached. The manual sorting system may be replaced by a sorter (automatic sorting system). The washing process can be carried out using a rotating screw which also would serve to move the fish forward. As an alternative, the fish may be hosed down while they are being transported further. The weighing part of the procedure would take place at a central weigh scale, and the individual weights would be recorded, or input (possibly automatically) into a computer system. The computer system could thus write out the total weight of the various size groups when this is required.

(23) 4.4.2 Cleaning, washing, sorting, and weighing, Option 2 (Fig. 4.2)

This option assumes the use of existing cleaning machines, sorters, and a central weight scale. It is possible that one weight would be taken for each batch coming into the system. Use will be made

(Figure 4.1)

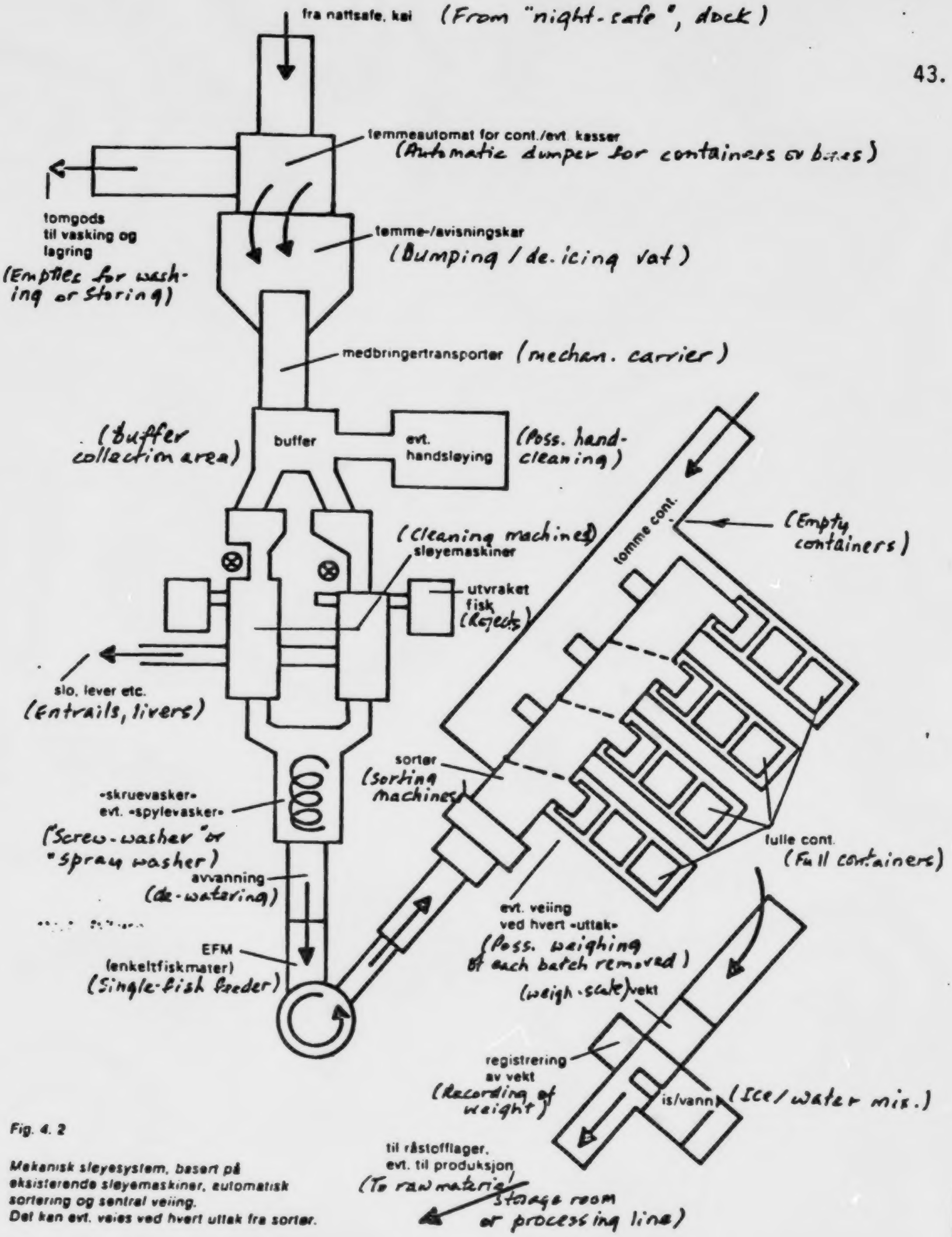

Fig. 4. 2

Mekanisk sløyesystem, basert på eksisterende sløyemaskiner, automatisk sortering og sentral veiing.
Det kan evt. veies ved hvert uttak fra sorter.

Figure 4.2 Mechanical fish-cleaning system, based on existing cleaning machines, automatic sorting, and central weighing. Weighing can possibly take place as each batch is taken out of the sorting-machine.

of rotor washing systems or (hosing-down systems). In order to avoid the situation where many fish would arrive at the sorter at the same time, a single fish feeder (EFM) would be used. The weighing system can function as outlined in Section 4.4.1.

(24) 4.4.3 Cleaning, washing, sorting and weighing, Option 3 (Fig. 4.3)

This system is based on the SLM (cleaning machine) and the use of single fish weigh scales (bulk weight scales or weighing at each batch withdrawal). The fish that come out of the cleaning machine will be automatically size-sorted, in such a way that they can go directly to the filleting line if this is desired. Instead of transporting the fish by conveyor belt over to the filleting area, containers or trucks (or even roller-bed tracks) may be used. The task of weighing of the various size classes and the calculation of the accounts payable to the fishermen are all taken care of by the sorting system associated with the SLM, the single fish scale (or bulk scale as the case may be), and the computerized data system.

Accounting bills and lists, as well as the necessary statistical records are provided directly from the computerized equipment. This is in order to minimize the routine administrative work.

The above system can be based on the use of transport conveyor belts for transporting individual fish as well as powered roller-bed laneways for transport of fish in containers, and can thus eliminate the need for trucks or fork-lifts. Inside the SLM machine, the fish are hosed down.

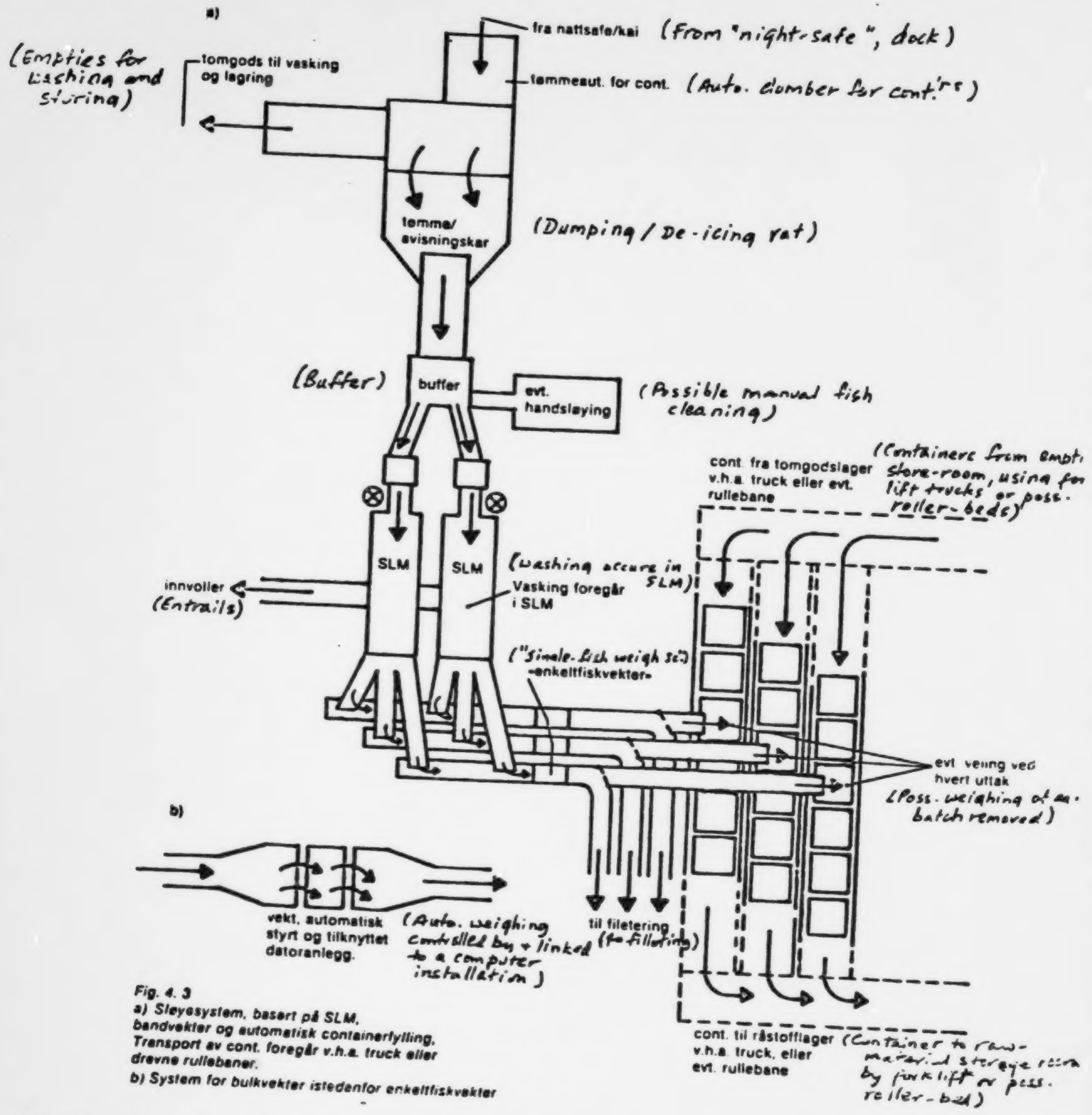
a)
fra nattsafe/kai
(From "night-safe", dock)
tomgods til vasking og lagring
(Empties for washing and storing)
tømmeaut. for cont.
(Auto. dumber for cont.'rs)
tømme/avisningskar
(Dumping / De-icing vat)
buffer
(Buffer)
evt. handsløying
(Possible manual fish cleaning)
cont. fra tomgodslager v.h.a. truck eller evt. rullebane
(Containers from empti store-room, using for lift trucks or poss. roller-beds)
SLM
SLM
innvoller
(Entrails)
Vasking foregår i SLM
(washing occurs in SLM)
-enkeltfiskvekter-
("Single-fish weigh sc.")
evt veiing ved hvert uttak
(Poss. weighing of ea. batch removed)
b)
vekt, automatisk styrt og tilknyttet datoranlegg.
(Auto. weighing controlled by + linked to a computer installation)
til filetering
(to filleting)
cont. til råstofflager v.h.a. truck, eller evt. rullebane
(Container to raw-material storage room by fork lift or poss. roller-bed)

Fig. 4. 3
a) Sløyesystem, basert på SLM, bandvekter og automatisk containerfylling. Transport av cont. foregår v.h.a. truck eller drevne rullebaner.
b) System for bulkvekter istedenfor enkeltfiskvekter

Figure 4.3 a) Fish-cleaning system, based on SLM, belt-mounted weigh-scales, and automatic container filling. Transport of containers is done using fork-lift trucks or powered roller-beds.
b) System for bulk weigh-scales instead of single-fish scales.

In places where automatic sorting systems are used independently of the SLM, the same system can also be used for sorting of the catch from the trawlers. This sorting procedure would take place after the fish are taken out from the raw material storage facility and prior to production. This system will be described in Chapter 7.

Generally speaking it is important that there not be too much reduncancy of equipment found in the various divisions of the plant. In order to minimize this, careful plannning of the arrangement of production lines is very important.

(26) 5. RECEIVING OF CLEANED FISH, DETERMINATION OF THE CATCH VOLUME

Within the receiving area, the following functions, among others, take place:

- Handling inside the storage room
- Transfer from the boat to the dock
- Grouping of fish according to type and time of catch
- 10% weighing and quality test, i.e. determination of the quantity of each species and size group as well as the quality of the entire catch. This test takes place in connection with delivery of trawler catches
- Transfer to the raw materials storage facility

The way in which these functions are carried out are to a large extent dependent on how the fish are stored onboard the vessel and on land.

5.1 Storing techniques onboard the vessel and on land

The most common methods for storing fish are:

a. Fish are packed in ice within crates. This is the traditional method and yields satisfactory quality if the job is properly carried out (proper application of ice and use of the neck-fold technique).

b. Fish are packed in ice inside containers. Following the experiments on the trawler, Sjong, cod is now stored for 8 days using this technique and is of equally good quality as cod packed in ice inside crates (FTFI Report No. 662,1-5-1).

c. Fish stored in containers holding a mixture of water and ice. These containers measure approximately $1m^3$, and are about 60% fish (CSW). The experiments showed that the quality retention is about the same as is the case with packing in ice. In addition, fish stored in containers are less prone to bruising than fish packed in crates.

d. Fish kept in a chilled condition inside tanks (either in sea water that is chilled mechanically and circulated between the tanks (RSW), or in sea water / ice mixtures (CSW)). The main problems associated with this type of system is a large number of tanks in relation to the fish types and catch dates, as well as problems associated with unloading. Sorting by type can take place on land.

e. Fish in containers in which chilled sea water is circulated, i.e. RFW containers. These containers are more expensive and the necessary attachment of the hoses makes the system complicated.

Crates filled with ice is, as mentioned above, the traditional system in use today. It is a reasonable assumption to make that all the other methods can be developed into useful systems. However, the system involving containers holding an ice / water mixture is the system which for the present appears to be most attractive of all these "new systems". We will therefore examine only this storage technique in comparison to the use of crates.

(27) 5.2 Handling within the loading room

Arrangement possibilities inside the loading room are rather limited. This is because the fish must be able to be loaded in the storage containers even while the boat is at sea. In addition, the loading room must be able to hold both empty and filled containers, as well as ice.

The packing of the crates with ice is a very time-consuming operation. The handling and stacking of crates can also be time consuming as well as heavy work. The stacks of crates must be secured in a very careful way. Use of crates, however ensures a good stacking capability.

When container storage is used, the volume utilization inside the loading room would be somewhat less efficient, but it is still possible to arrange the transport systems, guide-ways, and the like, in such a way that the containers can remain solidly secured during the fishing operation. This would represent a considerable improvement, and in addition, would eliminate the work associated with ice packing. During loading and unloading operations it is necessary to have overhead tracks or the possibility to use fork-lift trucks inside the room. This does not present any great problem in the case of new vessels under construction, but for existing vessels, these problems can represent a considerable negative factor. Recent developments in systems for handling goods on regular cargo ships have gone in the direction of greater load units and mechanical equipment.

5.3 Transfer from boat to dock

In the case of unloading operations involving crates or containers, the use of cranes is the most flexible. Under normal conditions, one crane operator and one man stationed at the hatch opening are required. However, remote control equipment is presently available which would allow the crane operator himself to stand beside the hatch opening.

When unloading crates, one can consider the use of equipment mentioned in Chapter 2. In the use of crates or containers, there is the possibility of equipping the vessels with side openings and using fork-lift trucks for loading and unloading, as is the case with regular cargo ships. This would eliminate the need for one or two persons when compared with remote controlled operations. In addition, when the vessel has ports in its side, powered roller-beds may also be used.

When containers and remote-controlled cranes are used, the unloading operation could be carried out with five men, two of whom are stationed inside the storage room, one crane operator, and two stationed on the dock (this includes the fork-lift operator as well).

5.4 Type-sorting of the catch

One problem that arises in the case of crate storage, is that of keeping the various fish types and fish from various days separated from each other. Segregation of the various crate stacks can be carried out partly inside the loading room and partly on the dock. Mechanical equipment for segregating the crates on the dock can be constructed, and this can serve to make the job easier. With respect to working conditions inside the loading room, the segregation of crates should preferably be done on land.

When containers are used, however, the problems involved with segregation of the various fish types is not so great. This is because the contents of a container represents approximately the contents of one entire crate stack, and also the contents of this container is homogeneous insofar as fish type and day of catch are concerned. Judging on the basis of the quality of the raw material, manpower requirements, and working conditions both in the loading room during the fishing expedition and during unloading, it appears that containers eventually will replace crates as the storage unit for clean fish.

(28) 5.5 Determination of catch size (10% test)

Nowadays, a "10% test" is used to determine the amounts in each type- and size-class, as well as the total catch size. At the same time, an inspection can be made of the fish quality (smell, colour, and consistency).

The intention is that 10% of each day's catch be tested, but in actual practice, one crane-lift in 10 is taken. Since there are 12 crates in each crane-lift, and of the 70 litres in each crate 40%

is composed of ice, this amounts to about 4536 (9x12x70x0.6) kg of fish in each test, and this might be an overestimation. It is uncertain whether one thus obtains an accurate "picture" of the catch. Experience has shown that the establishment of the total catch size on the basis of the 10% weight test is usually in good agreement with test-weighing involving the entire catch. However, whether the 10% test gives a good idea of the size distribution of the catch, is still uncertain. The size distribution of the catch is important from a price point of view, and thus is a crucial parameter for both parties.

Sampling with shorter intervals between each sample and lesser amounts in each sample should yield better results. In order to obtain an insight into this problem, a further investigation should be conducted.

In the chapter on utilization of the raw material , the importance of obtaining as high a quality of raw material as possible was dicussed. The quality control carried out in the 10% test must therefore be made to contribute to this control.

In addition, all fish undergoing the 10% test should be passed directly to the processing plant for quality retention reasons.

Use of containers will make the 10% test more difficult to carry out, both insofar as weight and quality determinations are concerned. If one does intend to take out about 10% of each container load, this would entail much handling of the containers, container lids, and "scooping-devices". The development of an effective apparatus for scooping can also present problems.

If each 10th container is extracted and dumped, this would represent a very crude sampling approach as approx. 5.4 tonnes will pass between each sample, and each sample will comprise only 600 kg. In the case of some "dressed" fish, this can mean a whole day's catch between each sample.

I will now outline two alternative points in time for invoicing for use in connection with containers. Furthermore, I will touch on the approach of estimating weight on the basis of the length and geometry of the fish.

5.5.1 Invoicing at the time the fish is taken in for processing

In this system, a reasonable number of spot samples are taken to estimate fish quality when the catch is deposited in the raw material storage room. Quality inspection is most stringent for those catches which were stored the longest time onboard. At the time that the catch is placed in the raw material storage room, the quality is determined and the container is marked with the name and number of the vessel, the fish type, catch date, and quality. The vessel receives a receipt for the number of containers of each fish type and catch date, stating the quality of the fish as well. From this information, the approximate size of the catch may be deduced. If required, a provisional invoice may be drawn up. At the time that the catch is taken for processing, the final weighing can take place.

(29) The entire catch is measured and weighed, so that the accurate establishment of catch size can be made. At this time, the final invoicing may be done.

Naturally, situations will arise which result in the postponing of the time of invoicing, and that the plant must undertake the weighing by itself. (In the case of agriculture, it is the sales co-operative which alone is responsible for invoicing after the farmer has shipped animals to the abatoir). One practical difficulty in connection with the invoice calculation in this case is that the fish absorb considerable amounts of water lying in the ice / water mixture (see Fig. 5.1). This difficulty could be avoided if the parties to the transaction agree on a time- and fish-type-dependent weight reduction factor for fish held in water (i.e. $\eta = f(\text{time, fish type}) \leq 1$).

5.5.2 Determination of the catch size onboard the vessel

When the cleaning machine is used as a size-sorter and weighing device, or manual sorting and weighing are carried out, it is possible to determine the size distribution of each fish-type as well as the total catch size. This can thus be carried out onboard the larger fishing vessels. The required data are entered into a computer and can be printed out on demand. The computer unit used must be protected from outside manipulation. When the catch is delivered, a quality control check is conducted and afterwards, the final accounts payable statement can be drawn up. When the catch is taken in for processing, the plant will then be able to check the data they received from the vessel. As mentioned previously, the figures must be adjusted for water uptake.

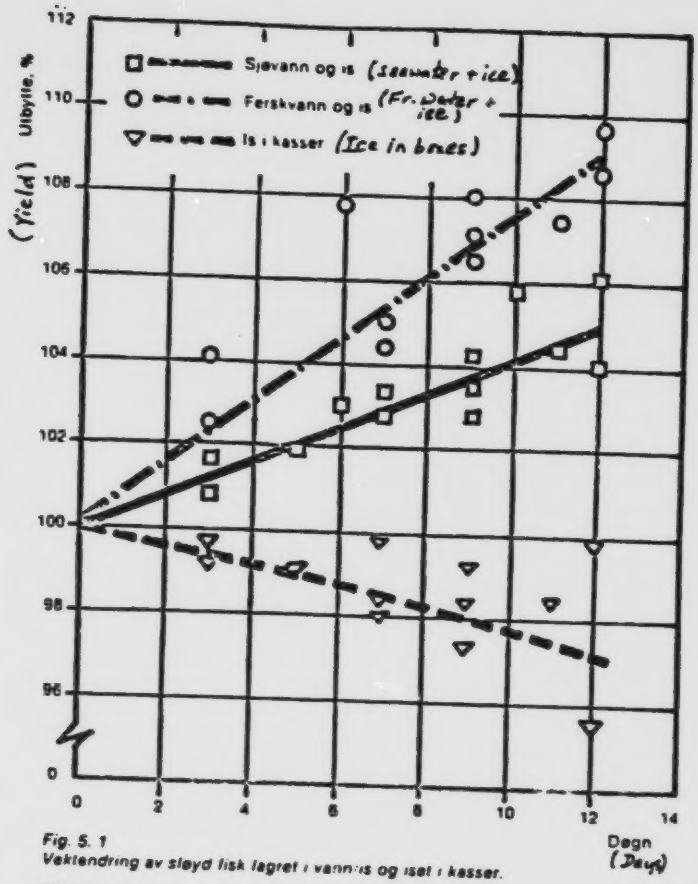

Fig. 5. 1
Vektendring av sløyd fisk lagret i vann-is og iset i kasser.

Kilde: [2]

Figure 5.1 Changes in weight of cleaned fish stored in water/ice mixture, or in boxes. (SOURCE (2))

30

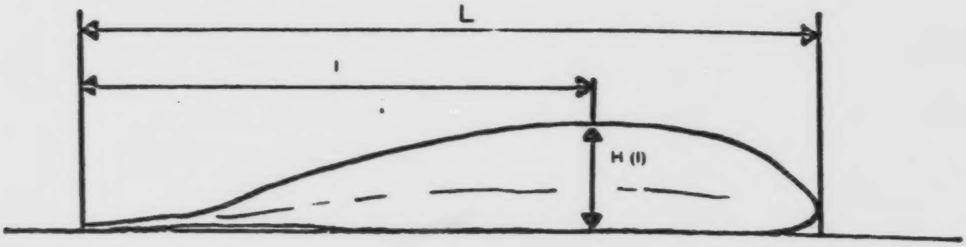

Fig. 5. 2
Estimering av fiskens vekt ut fra profil og/eller lengde.

Figure 5.2 Estimating fish-weight using profile measurements, and/or length alone.

(30)

5.5.3 Determination of fish weight from measurements of the fish's geometry.

By an accurate and continuous measurement of the shape of the fish, it is perhaps possible (using a calculation program or algorithm) to estimate the fish weight within certain set tolerance limits. A "formula" must be made up for each fish type. For example, such a formula for determining cod weight from its geometry measurements can be expressed as follows:

$$F\ (\mathrm{cod}) = F\ (H\ (I),\ L),$$ where

F is the weight.

A simpler formula is

$$F\ (\mathrm{cod}) = F\ (L)$$

(see Fig. 5.2).

Such measurements can be taken in a measuring device associated with the cleaning machine or the sorting installation. The calculation is done in a computer. If such a calculation procedure is deemed accurate enough, the "weighing" of the catch, either onboard or on land, can be considerably simplified.

5.6 Production lines for the 10% test

5.6.1 10% test, Option 1, Fig. 5.3

The entire system is based on sampling (scooping) from each container, or on dumping each 10th container, for example. Each 10th crate is then taken in for the test. In the case of crates, crane

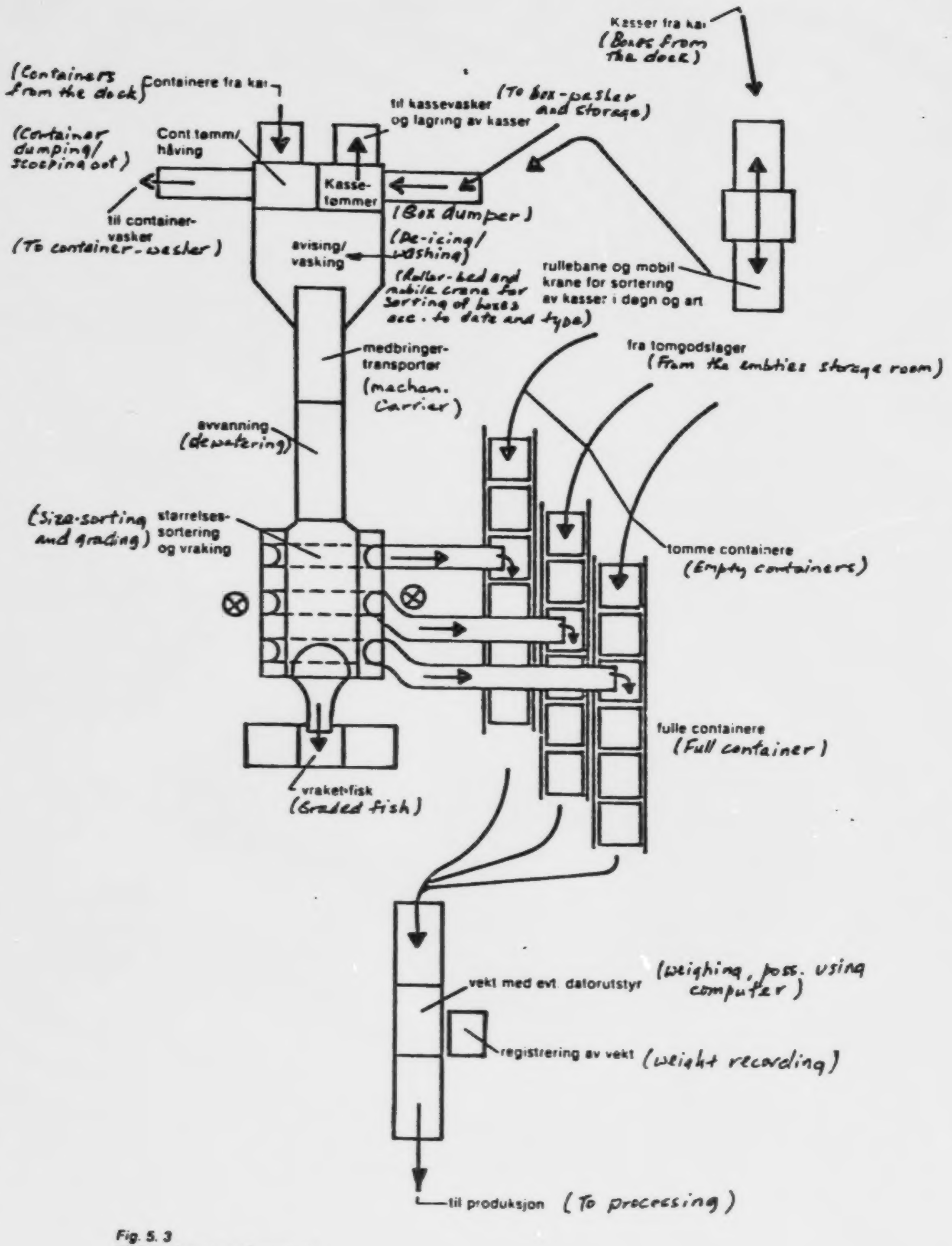
Kasser fra kai
(Boxes from the dock)
(Containers from the dock)
Containere fra kai
til kassevasker og lagring av kasser
(To box-washer and storage)
(Container dumping/scooping out)
Cont.tømm/håving
Kassetømmer
(Box dumper)
til containervasker
(To container-washer)
avising/vasking
(De-icing/washing)
(Roller-bed and mobile crane for sorting of boxes acc. to date and type)
rullebane og mobil krane for sortering av kasser i døgn og art
medbringertransportør
(mechan. Carrier)
avvanning
(dewatering)
fra tomgodslager
(From the empties storage room)
(Size-sorting and grading)
størrelsessortering og vraking
tomme containere
(Empty containers)
fulle containere
(Full container)
vraket fisk
(Graded fish)
vekt med evt. datorutstyr
(weighing, poss. using computer)
registrering av vekt
(weight recording)
til produksjon
(To processing)

Fig. 5. 3
10 %-test, basert på manuell
størrelsessortering manuell- eller
automatisk containerfylling og sentral
vekt med manuell eller automatisk veiing og utregninger.

Figure 5.3 10% test, based on manual size-sorting, manual or automatic container-filling, and a central weigh-scale, with manual or automatic weighing and accounting.

equipment and roller-beds are used for sorting the crate pallets in terms of catch day and fish type. The size sorting and quality control is done manually, and bulk weighing is carried out. Input of the values and calculations can take place automatically with the aid of a computer. Transport is by fork-lift truck.

5.6.2 10% test, Option 2, Fig. 5.4

The system is primarily based on the use of containers. Single fish weighing scales and sorting personnel are used in determining the amounts and for size sorting. A manual quality control is carried out. The fish can afterwards be held in containers for transport to the filleting lines, or can be sent there directly by conveyor belt. If single fish scales cannot be used, a bulk weight device must be inserted into each line, or automatic filling of the containers with weighing taking place afterward. The weighing can be done automatically at the filling station or at a central weigh-scale. Input of the values and calculations can be done using a computer.

5.6.3 10% test, Option 3

This alternative is based on container use and a delayed invoicing procedure. Spot (individual) samples are taken from individual containers and used for quality control, but especially from those containers with the "oldest" fish. The number of containers of each fish type is input. A receipt for the number of containers of

(31) each fish type (and showing the quality) is printed out for the vessel.

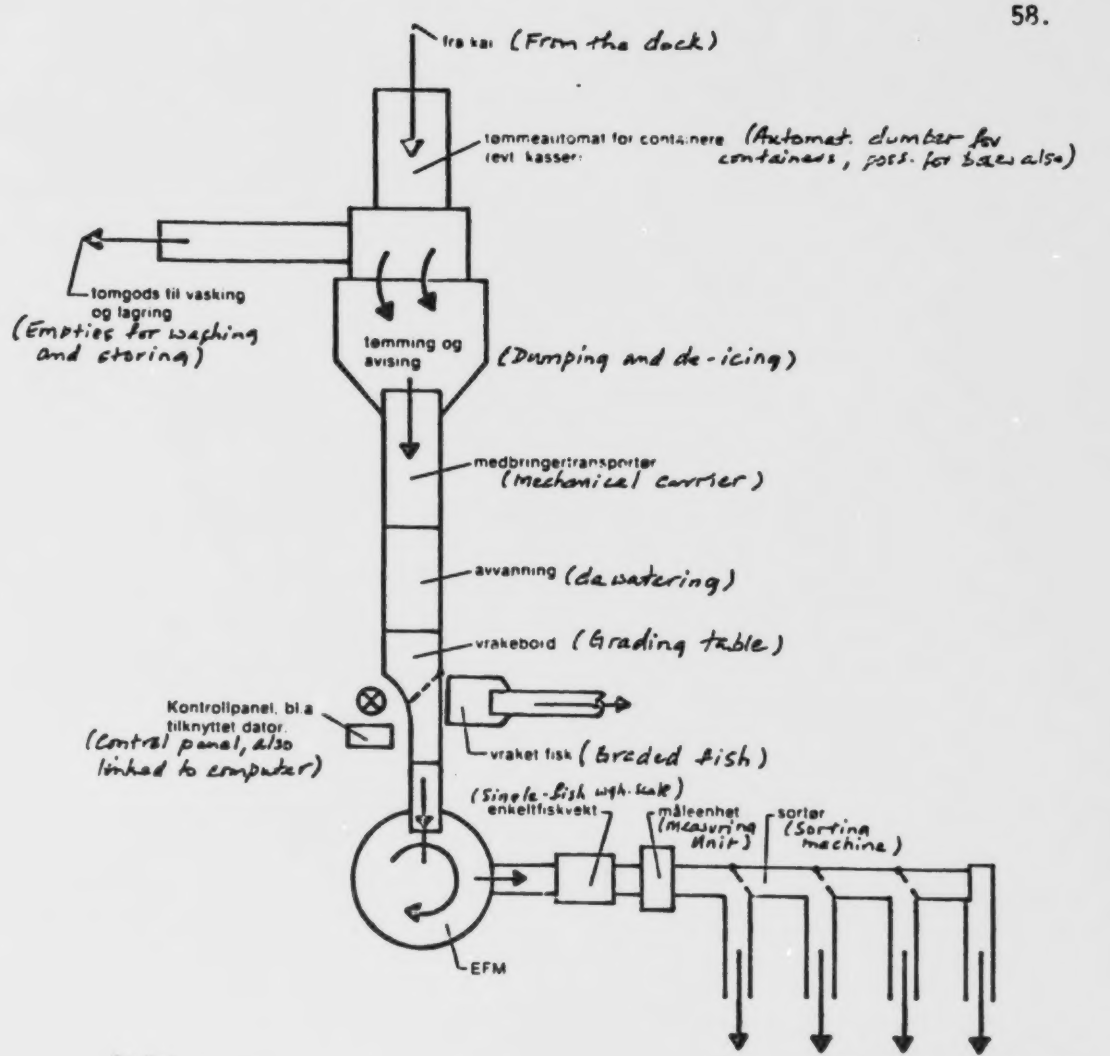
fra kai (From the dock)
tømmeautomat for containere (evt. kasser) (Automat. dumber for containers, poss. for boxes also)
tomgods til vasking og lagring (Empties for washing and storing)
tømming og avising (Dumping and de-icing)
medbringertransporter (Mechanical carrier)
avvanning (de watering)
vrakebord (Grading table)
Kontrollpanel, bl.a tilknyttet dator. (Control panel, also linked to computer)
vraket fisk (Graded fish)
(Single-fish wgh. scale) enkeltfiskvekt
måleenhet (Measuring Unit)
sortør (Sorting machine)
EFM
Fylling i containere for evt. veiing og transport til filetering, eller transport på band direkte til filetering.
(Filling containers for eventual weighing and transport to the filleting room, or transport on conveyor belt direct to filleting)

Fig. 5. 4
10 %-test, basert på automatisk størrelsessortering og veiing v.h.a. enkeltfiskvekt

Figure 5.4 10% test, based on automatic size-sorting and weighing, using single-fish weigh scales.

The containers are labelled and deposited into the raw material storage room. Size-sorting, determination of quantities, and the final drawing up of invoices are undertaken when the catch is taken in for processing. (See also Section 5.6.2)

(33) 6. THE RAW MATERIAL STORAGE ROOM

A large portion of the raw material delivered to the plant is contained inside the raw material storage room. The following factors are of importance for a storage room to operate satisfactorily:

a. The storage room's location in the plant

Such a location must be favourable with regard to transport and pathways to and from. In the designing of new plants it may be necessary to conduct a small transport analysis using transport flow diagrams, in order to come up with an appropriate placement of the store-room. However, in many cases other constraints act to limit the choice of site.

b. The capacity of the storage room

It is important that the store room posess an adequate refrigeration and floor-space capacity and that it be easy to maintain in good order. Raw material must not be forgotten or misplaced. This is important if the material is not to remain too long in the store room and thus become unsuitable for use as fillets. The interior design of the room is crucial in this regard, but if the store room is large enough, it is a relatively simple matter to keep things in order. In the case of new constructions, attention must always be given to both overhead clearances as well as good access to the raw material when establishing room dimensions.

c. First in - first out

This principle is crucial in the lay-out of the storage room. In principle it means that the arrangement must be such that the fish which "tolerates" the least storage time must be placed where it can be taken out first.

Any "shifting around" of the stored material must be avoided. By "shifting around" we mean the necessity of taking something out of the store-room and returning it in order to take out another article. The principle behind "first in - first out" is easier to implement if 2 doors are used - one for incoming transport and the other for out transport.

6.1 Design of the storage room

The design of the store-room will for the forseeable future be similar to those of today. It is now possible to install shelving systems or roller-bed. Such expensive storage rooms cannot be justified today on economic grounds since no great increase in efficiency is achieved, and one is saved only one man and one fork-lift at most. One benefit would be to make use of higher ceilings and thus achieve a more orderly and easily managed facility. For this reason such a storage room is included among the alternatives.

We will therefore examine 3 different alternatives for storage room design.

6.1.1 Raw material store-room, Option 1

This design is the one used in store-rooms nowadays, but it has one door for in-transport and another for out-transport. Since there is a large amount of "selection" of the raw material stored in the room (according to vessel, type, and day of catch), the floor of the store-room can be divided up into numbered spaces.

(34) Bulletin boards with areas drawn on to represent these spaces can be hung outside the store-room. In this way one can use the bulletin boards to keep track of what is stored where in the store-room. Computerized techniques can also be used in this connection. Fork-lift trucks are used as transport vehicles.

6.1.2 Raw material store-room, Option 2

This type of store-room consists of shelved space (i.e. deep-stacking storage units or roller-beds storage units). Such systems can contribute to improved use of the vertical space of the store-room. Roller-bed storage units can consist of inclined roller-beds, so that input can be gravity-assisted. Input of material occurs at one end of the roller beds, and output is from the other end.

Such a store-room system can lead to improved order and management of the store-room. Keeping track of stored items is possible using bulletin boards or a small computer system. Transport is by fork-lift truck.

6.2.3 Raw material store-room, Option 3

This store-room type consists of inclined roller beds (or powered roller beds as the case may be) for transport out and in. The store-room is automatically managed (monitored) by computer. In this way, programs can be set up in such a way that entry to the store-room, taking goods out of the store-room, and information as to what is stored where in the store-room, can be obtained using a simple "push-button system". Such a store-room is based on use of containers, and transport to and from the roller beds at higher levels is carried out using elevators.

6.2 Tank storage on land

Since tank storage is possible onboard vessels, one should consider their use on land for storing raw material.

Transport from tanks onboard to tanks on land can be done in water, through conduits. Such a technique would probably be necessary in order to avoid undue damage to the fish. Such a system would also require an invoicing procedure that is postponed until the time that the fish is taken in for processing. It is conceivable that a system will be developed which would estimate the size and weight of the fish while it is being transported through the conduit. However, it would probably be several years before such a system can be realized.

(35) FILLETING LINES USING RAW MATERIAL FROM THE STORE-ROOM. SIZE-SORTING, WEIGHING, AND YIELD MONITORING.

7.1 Taking goods out of the raw material store-room

Means of transport now possible in connection with taking goods out are fork-lift trucks, poweeed roller beds, or trackways mounted on the ceiling. The taking-out operation can be controlled manually or with the aid of a computer.

In the first case, a completely standard storage room or a shelved store-room is used. Fork-lift trucks are used for transport.

In the case of automatically controlled store-rooms, roller bed or powered roller bed units may be used to take the goods out of the store-room. Shelving systems and trackways under the ceiling can also be considered as possible transport options.

As mentioned previously, it is believed that, for the time being, automatically controlled raw material storage-rooms are not very likely, because of the slight benifit their use would bring.

Dumping in the de-icing / washing vat can be done using automatic dumpers. In the Wash vat, the water must be changed in accordance with the Fresh Fish Regulations. Upward transport of the washing vat is carried out by mechanical carriers. This entire system (dumping, de-icing / wash and out transport of the vat) must be set up in such a way as to provide a minimum of noise and water splashing. This is part of the requirements for a good working environment. Other systems than vats are also conceivable for use in the de-icing / washing operation.

7.2 Sorting according to size, weight

7.2.1 Sorting

It is important that fish be sorted according to size. Some of the main reasons for this are:

a. Cutting yields

In order to obtain an optimal cutting yield, it is important to use fish of the size for which each filleting machine was set up for. In general, a filleting machine cuts best when the fish lie in its upper size range, but the machine can be adjusted so that it cuts better for smaller fish. However, it would then not do such a good job as before on the larger fish. This is illustrated in Figure 7.1. The figure is meant only as an illustration and should not be taken "literally".

b. Sorting out on the basis of the size limits

As shown in Fig. 7.1, there is an upper and a lower limit for the various types of filleting machines. Fish that are too large can lead to the machine going out of adjustment, or in worse cases, to breakage of knives, shafts, etc. Too small fish can lead to a very poor cutting job and thus very poor yields. Because of this, it is important that the oversize and undersize fish be sorted out prior to this operation.

(36) c. Fish destined for a particular use

At times, it is desirable for the fish size to correspond to the use that it will eventually be put. In such cases, it is important that a system for size sorting be in place. Examples of the above situation are:

- Relatively large fish are desirable for salting
- Small or large fish are desirable for hanging
- Small or large fish are used for various fillet types, e.g. cubes or for consumer purchases, respectively. These two fillet raw material types are run through different production lines.

7.2.2 The sorting system

The storage system discribed here can be carried out either manually or mechanically. In the latter case, a sorting system we

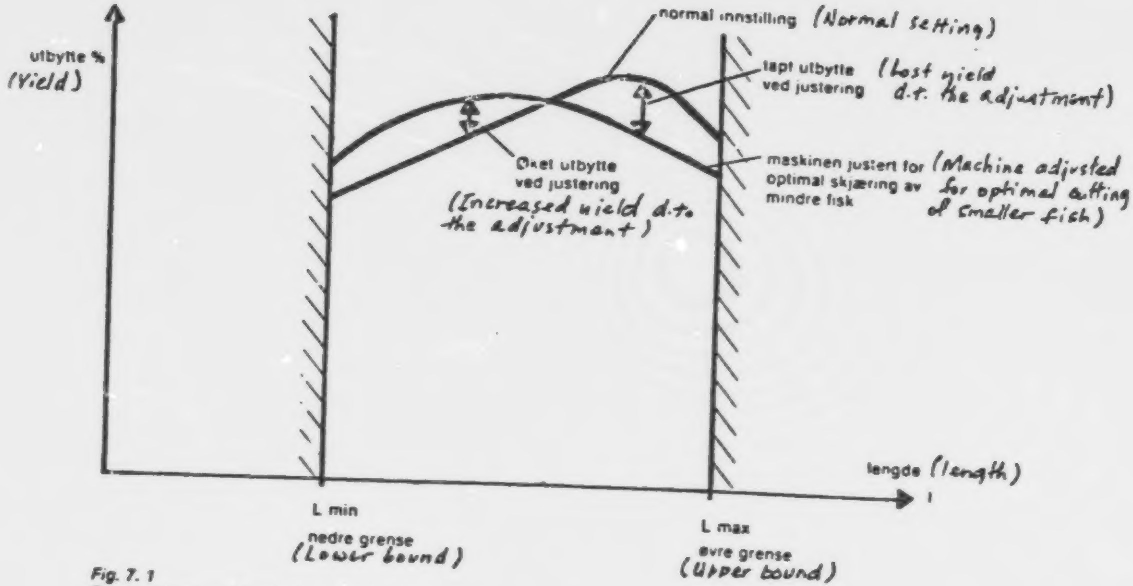

Fig. 7. 1
Skjæreutbytte ved forskjellige justeringer av fileteringsmaskin.

Figure 7.1 Cutting yields at various settings of the filleting machine

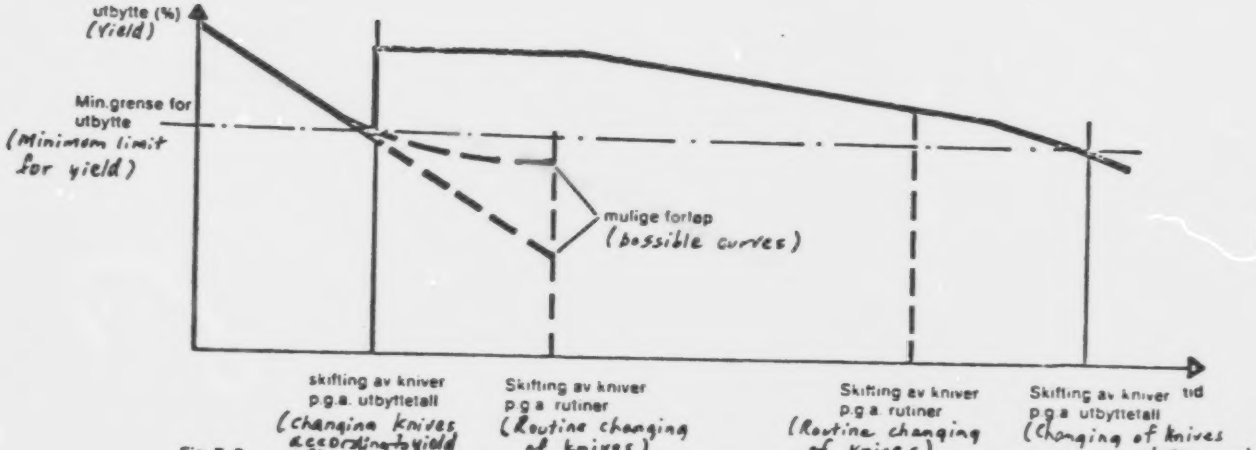

Fig. 7. 2
Skisse som viser tenkt forløp av utbytte som funksjon av tiden, samt tidspunkt og skifting av kniver p.g.a. utbyttetall og p.g.a. rutiner.

Figure 7.2 Curves of the assumed behavior of yield figures as a function of time, together with the times of knife-changes based on yield figures and also on routine schedules.

call a "sorter machine" is used, The sorter is capable of sorting fish into a number of specified size groups. Attached to the sorter can be a computerized system with programmable software which could also stipulate adustable size limits. This is in order to supply all the filleting lines with a sufficient number of fish. The sorter is, for the most part, composed of the following:

a. A unit which measures length, and possibly geometry, of the fish, similar to the unit used in the cleaning machine (SLM) described previously.

b. Calculator unit, in which the length and geometry (as the case may be) and other data are run through various calculations.

c. Control unit which opens the right flap.

(37) d. Conveyor belts with flaps. The belts carry fish through the measuring unit and over to the output flap corresponding to the fish's size group.

The fish must pass the measuring unit parallel to the edge of the conveyor belt and in single file with a certain amount of space between each fish. A manual placement of the fish on the belt (5 - 6000 fish per hour) represents a work task which we (FTFI) wish heartily to avoid. We have therefore initiated experiments using a system to feed fish to the sorter machine in the manner outlined above. We call this system "the single fish feeder" (EFM). It presently looks as if an arrangement might be possibly developed which would operate well enough for an operator to tend it along with other units (automatic dumper and the sorter machine as well). The sorter machine shown in

Fig. 7.3 is somewhat elongated, but it would be no great technical problem in making a considerably shorter version.

7.2.3 Weighing

This operation is carried out in conjunction with the initial input of the raw material and / or in conjunction with yield control.

The weighing can take place at a weigh scale incorporated into the system (beyond the sorter machine) for each filleting line. This scale weighs on a batch basis (bulk weight). By this is meant a scale that is placed between two buffer areas, and which weighs a certain quantity of fish in each weighing operation. It is also conceivable that the weighing operation be carried out using a single-fish weigh-scale which can be set up in between the EFM and the sorter machine, or beyond the sorter machine but in front of each filleting line. The weighing systems can be coupled to a computerized device which would sum up the fish weights going to the various filleting lines, for dried and salt fish, as well as the total. The same computer system can be used to calculate the fillet yields, etc.

This matter of the weighing and computer systems will be discussed in more detail in the section on yield-control. Estimation of fish weight from measurements of the fish's geometry was outlined in earlier sections.

7.3 Filleting lines

7.3.1 Removal of heads and ear-bones

The first operation on the filleting line is the removal of the ear-bone along with the neck portion. This usually is done in

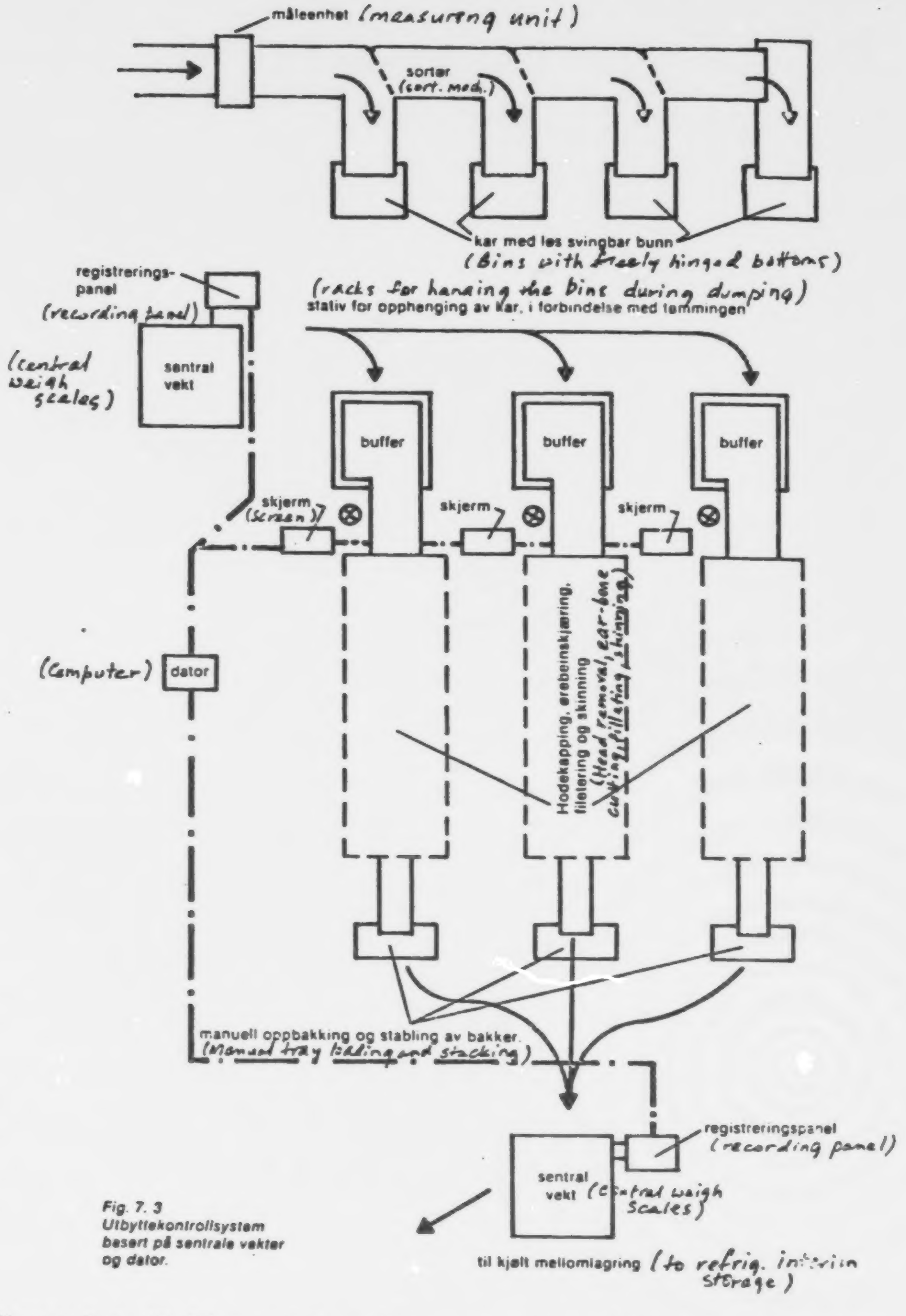
måleenhet (measuring unit)
sorter (sort. mod.)
kar med løs svingbar bunn (Bins with freely hinged bottoms)
(racks for hanging the bins during dumping)
stativ for opphenging av kar, i forbindelse med tømmingen
registrerings-panel (recording panel)
sentral vekt
(central weigh scales)
buffer
buffer
buffer
skjerm (screen)
skjerm
skjerm
(Computer) dator
Hodekapping, ørebeinskjæring, filetering og skinning
(Head removal, ear-bone cutting, filleting, skinning)
manuell oppbakking og stabling av bakker.
(Manual tray lidding and stacking)
registreringspanel (recording panel)
sentral vekt (Central weigh Scales)
til kjølt mellomlagring (to refrig. interim storage)

Fig. 7. 3
Utbyttekontrollsystem
basert på sentrale vekter
og dator.

Figure 7.3 Yield control system based on central weigh-scales and computer.

a machine intended for beheading, and this can result in too much material being cut away (contributing to poorer fillet yield). In some operations, the ear-bone is cut away by hand. One type of filleting machine can be equipped with a unit which also can cut away the ear-bones.

There is a machine on the market which cuts the fish into 3 sections: head, ear-bone, and "body". The use of such a machine, along with fish delivered with heads attached, can increase substantially the fillet yields, as mentioned in Chap. 1.

This machine is especially attractive in cases where fish is delivered with heads attached, and hopefully will be soon available on the market.

(38) 7.3.2 Filleting

Filleting is done using various types of filleting machines. The various machine types are constructed to cut fish in various size ranges. Certain plants do not possess machines capable of handling large fish (lengths in excess of 80 cm, without head, for instance), and these fish must be filleted by hand.

Filleting machines section fish in three: back-bone with rib-bones, and 2 fillets with skin on. One type, mentioned above, can be equipped with a unit for cutting away the ear-bones. The same type can be equipped with another unit for cutting away the fin-bones. Such an operation implies that the fin-bones will be used for fish-pulp. This removal of the fin-bone can also be carried out in a separate machine.

Some types of filleting machines are constructed for direct attachment to a skinning machine, eliminating the need for an operator for the latter operation.

7.3.3 Skinning

Several different types of skinning machines are available. Most are adjustable insofar as skin thickness is concerned.

As mentioned above, combinations of filleting- and skinning-machines are found which do not require any operator(s) for the skinning-machine(s).

One combination which requires 2 skinning machines is for relatively large fish (50 - 120 cm). It is the filleting machine which determines the fish size that can be accomodated. Two other combinations, which require only one skinning machine, are for smaller fish. So far as is known, it is not possible to combine filleting machines which operate in the "normal" range (30 - 80 cm) with skinning machines without the need for an operator for the skinning machines. The machinery producers might do well to aim for such a product.

One can also envisage entire production lines, consisting of head / ear-bone removers, filleting machines, and skinning machines, being run by only 1 operator.

7.4 Yield control

As mentioned previously, yield control represents an important aspect of product control Nowadays there are large differences in how yield control is carried out from plant to plant. Some are aware of yield figures only from what they can extract from long-term production figures. Others use only the daily balance obtained between incoming weights and packaged quantities. Both these methods, however, represent only a means of record keeping, and provide little potential for being used on-line in the production process itself.

Those plants which are most seriously concerned over yields usually use the so-called 10-fish test. Approximately 10 evenly-spaced fish are run through a line and weighed before and after to obtain the necessary data. Based on these data, the various yield figures can be calculated. Machines and production lines which show low yield figures can thus be checked, and the necessary action taken (adjustment, knife sharpening, etc). Most plants carry out a periodic maintenance and replacement program, for example, on knives in the filleting machine 1 - 2 times daily. Replacement of knives therefore is carried out routinely. Visual appraisal also is a factor if a machine is discovered to be operating poorly.

(39) In addition, the interference of the operator can be open to critical examination. Each operator has his own optimal interference discretion, i.e. the level of interference which provides both good yields as well as high capacity. A too high capacity setting on the machines can lead to disproportionately low yields, and so it can be beneficial in some cases to set the capacity at a lower level.

Each operator, operating whatever type of machine, is able to undertake a visual monitoring of how the machine is "functioning", and what the yield should be. At the filleting machine, for example, the operator can keep an eye on both the fillet and the back-bone.

7.4.1 Systems for yield control

It is desirable to have a system which provides a yield figure for the various machines and production lines for the product period immediately preceeding. How long this period must be in order to provide a reliable figure must be decided on the basis of statistical principles and of the type of equipment used. Whenever the yield shows a falling trend and drops below a minimum threshold for that particular production line, then the machines involved must be checked, and the appropriate adjustment and maintenance carried out. How the yield figures can vary based on whether maintenance is routine (periodic) or based on monitoring the yield alone, is shown in Fig. 7.2.

In this section, we will be discussing 2 principal techniques of yield control systems, namely batch weighing, and weighing of every single fish. Both methods require de-watering of the fillets prior to weighing.

1. Batch weighing. Two different systems are proposed here. In Fig. 7.3 is outlined a system based on centrally located weigh-scales, linked to a computer. Weighed quantities along with the production line in question are punched in either by the fork-lift operator prior to the lines, or by the transport operator after the lines.

Alternatively, a pencil, pad, and hand-held calculator may be used for recording the weighed quantities to and from the lines, and for calculating the yield results.

(40) Figure 7.4 shows a system using buffers and weigh-scales before and after each line. The weight data are passed to a central computer unit, which calculates the yield figure for the entire line. The resulting yield figures are displayed on cathode-ray tubes (CRT's) for the operators to see, and to the foremean and production chief, as the case may be. The buffers and weigh-scales located after the skinning machines have a capacity limit of approx. 20 - 30 kilograms, while that of those in front of the lines is 100 - 200 kg. This is so that the filleted fish may not be piled up in such a large amounts and thus lead to loss of fluids. Dumping from buffer 1 into the weigh-scale and from the weigh-scale to buffer 2 is controlled either automatically or manually (by the operator). Weighing and filling up of the
(41) trays after the lines is automatic, or in some cases,transport of separate fillets is, instead, by conveyor belt. If the yield figure for a line, for a certain period, is to be really accurate, the line must be cleared of fish for reasons of the invoicing, so that everything "weighed in" would also be "weighed out". This operation is supervised by the operator(s). It is also possible to use an estimation of how much fish are between the weigh-scales at the time and, in this way, avoid the clearing of the production line.

(42) 2. Weighing of each individual fish. This system is presented in Fig. 7.5. It is based on individual fish weigh-scales, installed before the sorter machines and after each production line. In front of each line is a queueing-up system operating according to a first in / first out principle. Following passage through the lines, the fillets can be placed in trays for transport to a refrigerated interim storage

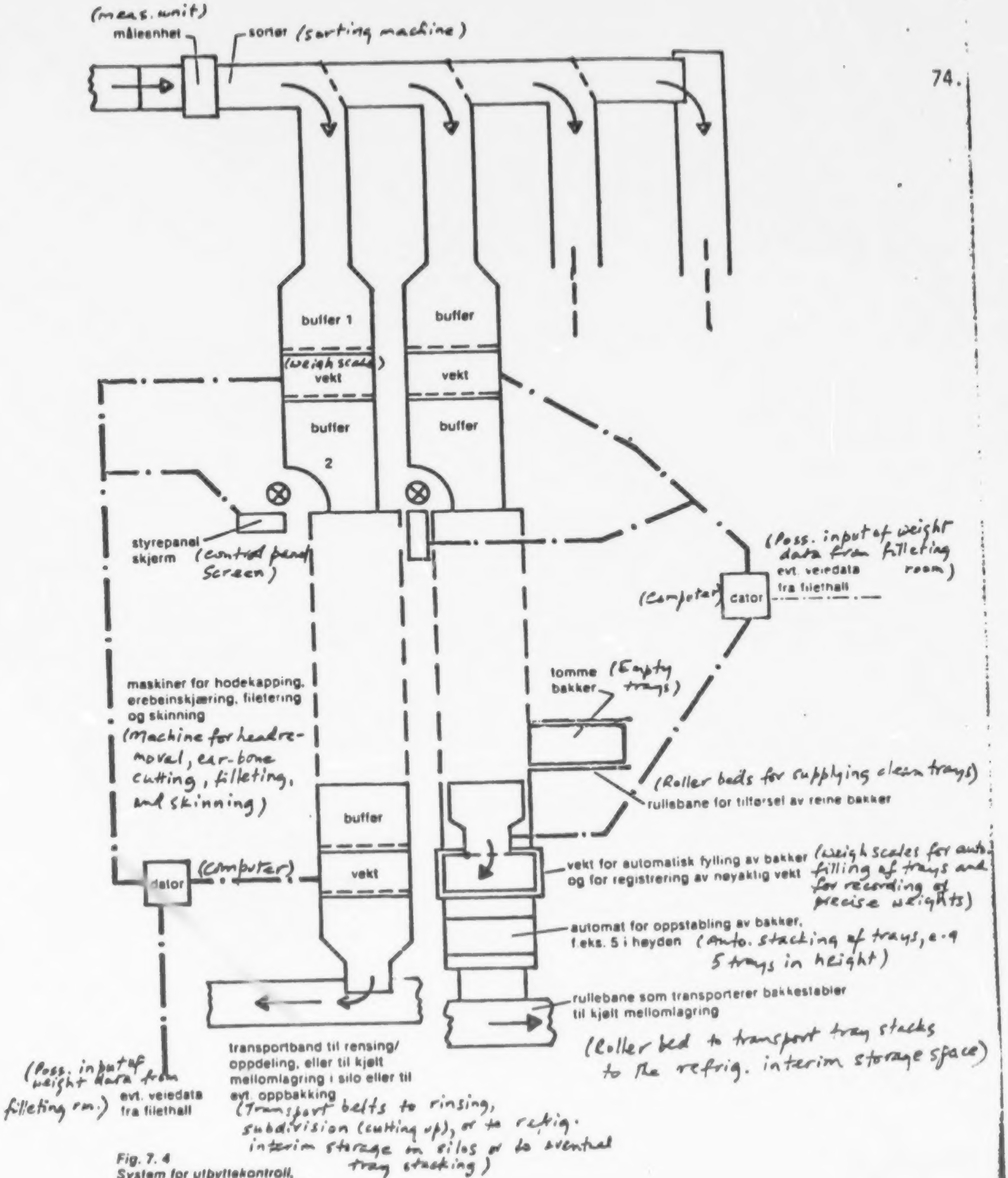
(meas. unit)
måleenhet
sorter (sorting machine)
buffer 1
(weigh scale)
vekt
buffer
2
buffer
vekt
buffer
styrepanel
skjerm (control panel
Screen)
(Poss. input of weight
data from filleting
evt. veiedata
room)
fra filethall
(Computer)
cator
maskiner for hodekapping,
ørebeinskjæring, filetering
og skinning
(Machine for head removal, ear-bone cutting, filleting, and skinning)
tomme (Empty
bakker trays)
(Roller beds for supplying clean trays)
rullebane for tilførsel av reine bakker
buffer
vekt
(Computer)
dator
vekt for automatisk fylling av bakker
og for registrering av nøyaktig vekt
(weigh scales for auto. filling of trays and for recording of precise weights)
automat for oppstabling av bakker,
f.eks. 5 i høyden
(Auto. stacking of trays, e.g. 5 trays in height)
rullebane som transporterer bakkestabler
til kjølt mellomlagring
(Roller bed to transport tray stacks to the refrig. interim storage space)
(Poss. input of weight data from filleting rm.)
evt. veiedata
fra filethall
transportband til rensing/
oppdeling, eller til kjølt
mellomlagring i silo eller til
evt. oppbakking
(Transport belts to rinsing, subdivision (cutting up), or to refrig. interim storage in silos or to eventual tray stacking)

Fig. 7.4
System for utbyttekontroll,
basert på satsvis (automatisk)
veiing, 2 alternative metoder for veiing ut av linjene

Figure 7.4 System for yield control, based on batch (automatic) weighing. Two alternative methods for weighing off-line are shown.

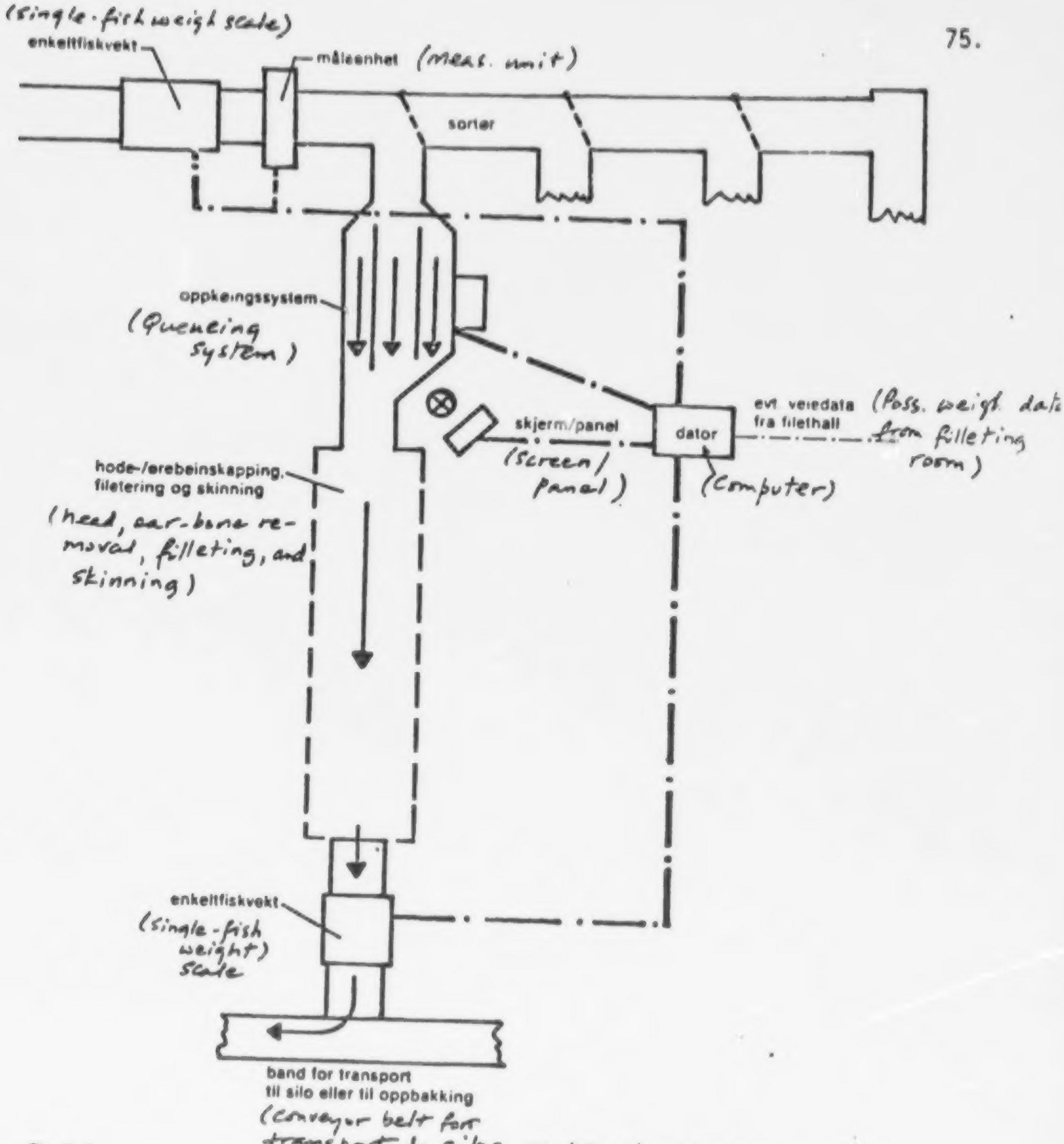
(single-fish weigh scale)
enkeltfiskvekt
måleenhet (Meas. unit)
sorter
oppkøingssystem
(Queueing system)
skjerm/panel
(Screen/Panel)
dator
(Computer)
evt. veiedata fra filethall
(Poss. weight data from filleting room)
hode-/ørebeinskapping, filetering og skinning
(head, ear-bone removal, filleting, and skinning)
enkeltfiskvekt
(single-fish weight) scale
band for transport til silo eller til oppbakking
(Conveyor belt for transport to silos or tray stacking)

Fig. 7.5
System for utbyttekontroll, basert på enkeltfiskvekter, oppkøingssystem og dator.

Figure 7.5 System for yield control based on single-fish weigh scales, queueing system, and computer.

room, or they may be transported there singly by conveyor belt. The computer unit linked to the weigh-scales "know" at any given time where each individual fish is. It receives weight data for each fish, and calculates the average yield figure for a given time-period or quantity. The length of the period or the size of the quantity can be determined by the operator(s). The fish on the line at the time are not included in the calculation.

If control is desired for each individual machine on the line, it is possible to bring in more weigh-scales and buffers in order to achieve this. Personally I feel that this involves too much weighing and represents too costly a system.

For both systems mentioned above, it is only the yield from the filleting lines that it is necessary to maintain some degree of control over. The weight data from the washing lines (tables) will arrive in the system after a considerable delay.

It is assumed in this chapter that a strict watch will be kept on yields. However, some control must also be maintained over the quality of the work that the machine does, a function that must be carried out visually. It is conceivable that in time, an optical equipment would be developed for carrying out this control.

An "anomalously high" yield figure can signify that some bone is being left in the fillets, and this should be taken into account in the control system.

7.5 Production lines for filleting, from the raw material store-room to beyond the skinning machine.

Many possibilities exist for combining such lines, three alternatives of which will be outlined here.

7.5.1 Filleting lines, Option 1 (Fig. 7.6)

The system is based on manual size-sorting and on fish with heads attached. The fish are brought in in containers or bins which are then weighed at a central weigh-scale. Following the weighing, the fish are dumped into the buffer at the start of the filleting line. Yield control is similar to that described in Figure 7.3. First, the head is removed in a standard machine designed for this purpose. On the filleting machine is mounted a unit for cutting away the ear-bones. Skinning machines, run by an operator, are used. After passing through the filleting machine, the fillets are placed in trays and these are stacked in stacks of suitable size, each stack consisting of trays from one line only. The tray stacks are weighed at a central weigh-scale. Filling the trays, stacking, and weighing may also be done automatically. Fish that are size-sorted during the cleaning operation, and have been stored in the raw material store-room, are dumped into the de-icing vat, but size-sorting is not necessary. Fish coming directly from cleaning to filleting may be dumped directly in the buffer in front of the filleting lines following weighing.

(45) 7.5.2 Filleting lines, Option 2 (Fig. 7.7)

This system is based on automatic sorting. The head is still attached and a machine is used which separates the head and ear-bone from the rest of the fish. The ear-bones are then separated

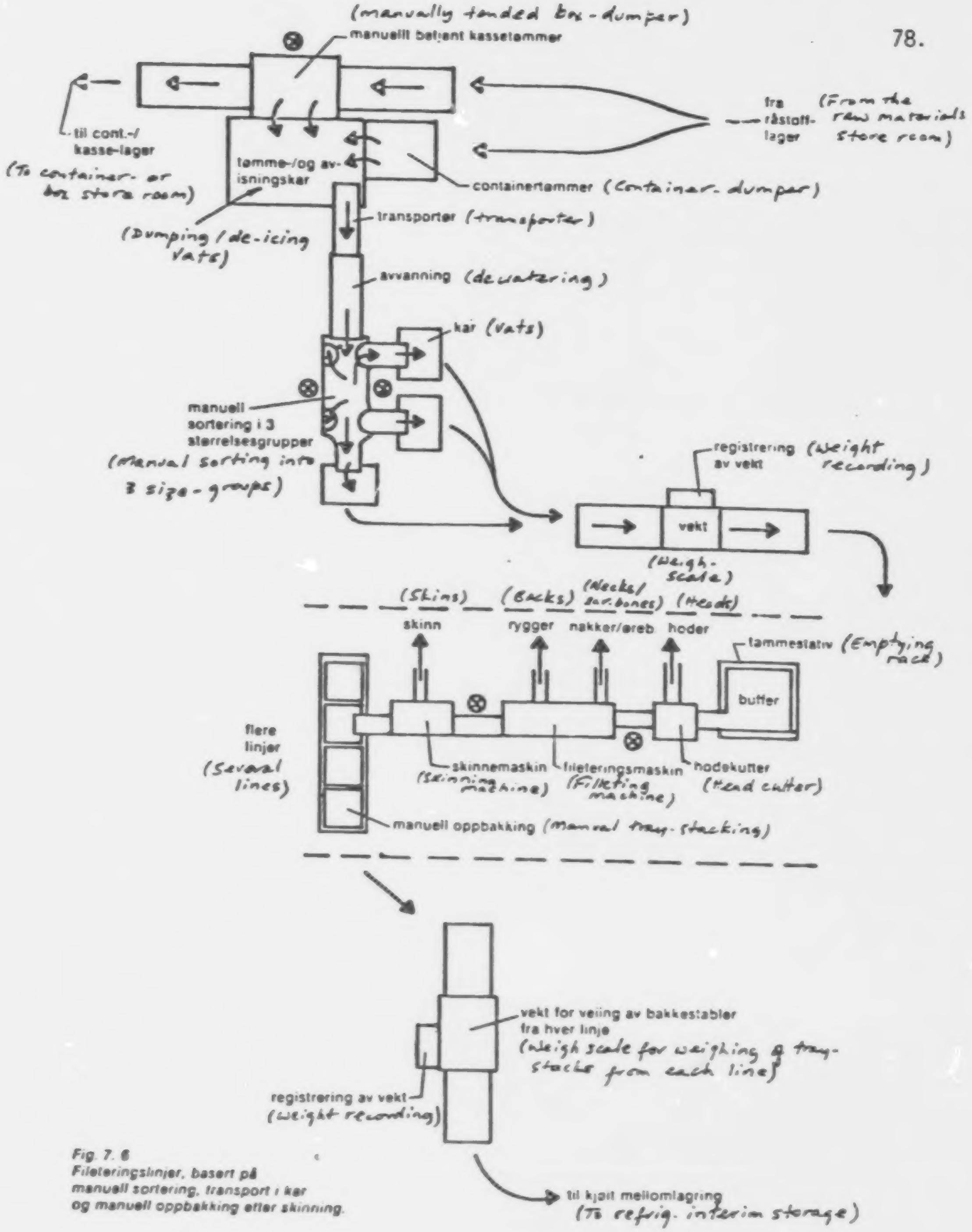
(manually tended box-dumper)
manuellt betjent kassetømmer
til cont.-/ kasse-lager
(To container- or box store room)
fra råstoff-lager
(From the raw materials store room)
tømme-/og av-isningskar
(Dumping / de-icing vats)
containertømmer (Container-dumper)
transportør (transporter)
avvanning (dewatering)
kar (vats)
manuell sortering i 3 størrelsesgrupper
(Manual sorting into 3 size-groups)
registrering av vekt (Weight recording)
vekt
(Weigh-scale)
(Skins)
(Backs)
(Necks/ ear-bones)
(Heads)
skinn
rygger
nakker/øreb
hoder
tømmestativ (Emptying rack)
buffer
flere linjer
(Several lines)
skinnemaskin (Skinning machine)
fileteringsmaskin (Filleting machine)
hodekutter (Head cutter)
manuell oppbakking (Manual tray-stacking)
vekt for veiing av bakkestabler fra hver linje
(Weigh scale for weighing of tray-stacks from each line)
registrering av vekt (weight recording)
til kjølt mellomlagring
(To refrig. interim storage)

Fig. 7.6
Fileteringslinjer, basert på manuell sortering, transport i kar og manuell oppbakking etter skinning.

Figure 7.6 Filleting lines, based on manual sorting, transport in vats, and manual tray-stacking after skinning.

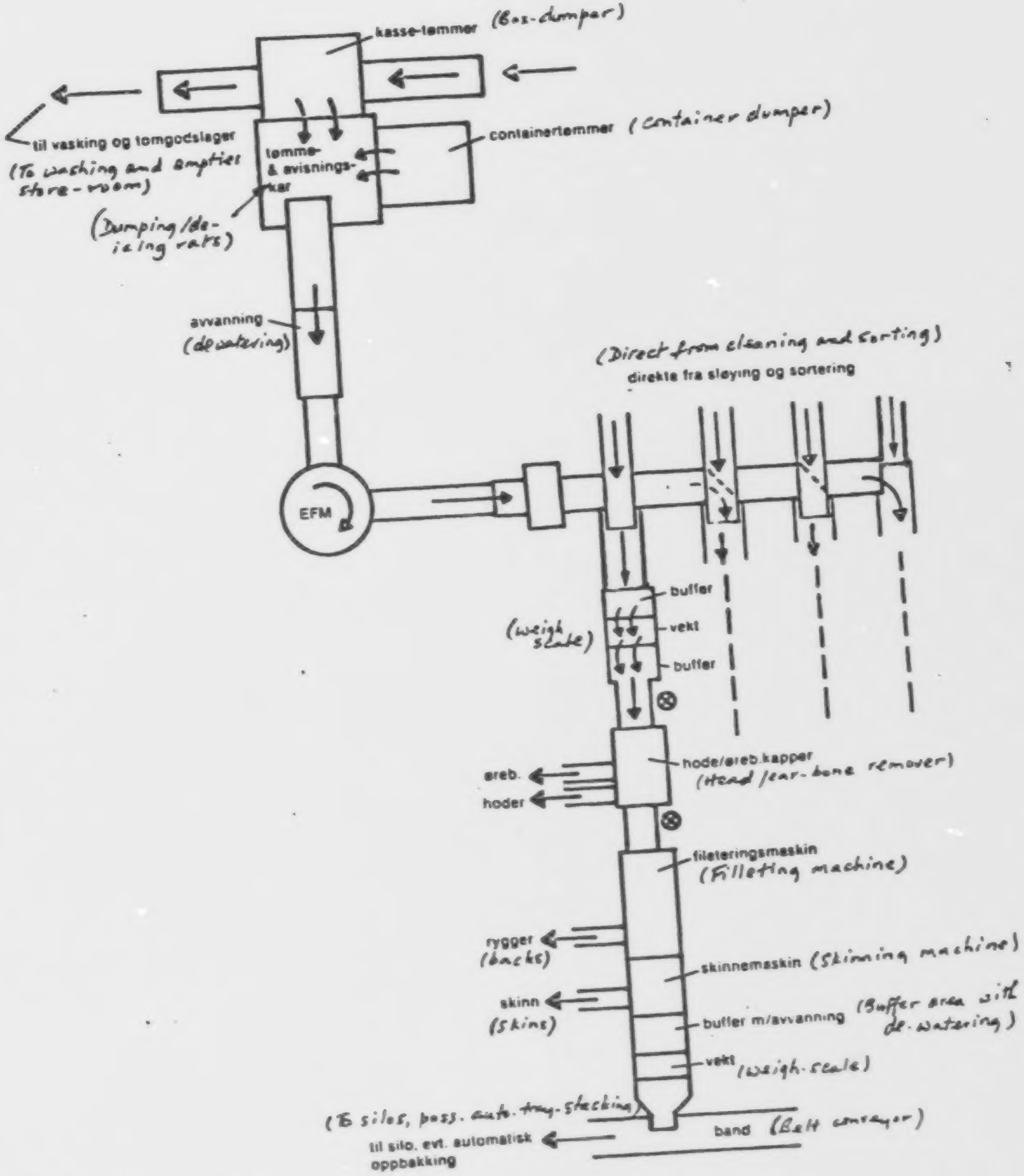
kasse-tømmer (Box-dumper)
containertømmer (container dumper)
til vasking og tomgodslager
(To washing and empties store-room)
tømme- & avisnings-kar
(Dumping/de-icing vats)
avvanning
(dewatering)
(Direct from cleaning and sorting)
direkte fra sløying og sortering
EFM
buffer
vekt
(weigh scale)
buffer
hode/øreb.kapper
(Head/ear-bone remover)
øreb.
hoder
fileteringsmaskin
(Filleting machine)
rygger
(backs)
skinnemaskin (Skinning machine)
skinn
(Skins)
buffer m/avvanning (Buffer area with de-watering)
vekt (weigh-scale)
(To silos, poss. auto. tray-stacking)
til silo, evt. automatisk oppbakking
band (Belt conveyor)

Fig. 7. 7
Fileteringslinjer, basert på automatisk størrelsessortering og skinnemaskin uten sorter.

Figure 7.7 Filleting lines, based on automatic size-sorting and skinning machines without sorting devices.

from the head. After this a normal filleting machine and skinning machines without operator are used. Alternatively, a normal head cutter and a filleting machine with an attached unit for removal of the ear-bone are used. For fish that were size-sorted during the cleaning process, the same system outlined in section 7.5.1 is applied. The yield control system is the one shown in Fig. 7.4.

(46) 7.5.3 Filleting lines, Option 3 (Fig. 7.8)

Only containers are used, brought in by roller-bed lanes and dumped automatically. The fish are delivered with heads attached. Single-fish weighing is done prior to the sorter machine.

In front of the head / ear-bone cutter is a queueing-up system based on a first in-first out principle. All 3 machines operate together, so that one operator is sufficient. The type of yield control is that shown in Fig. 7.5.

(47) 8. PRODUCTION OF FISH PULP

As mentioned in Chapter 1, a large proportion of the basic raw material today goes into the production of animal feeds. The reject parts can be used for producing fish pulp. Some important specifications are good quality and hygiene, proper production equipment, and a market willing to pay what the producer deems an acceptable price for fish pulp.

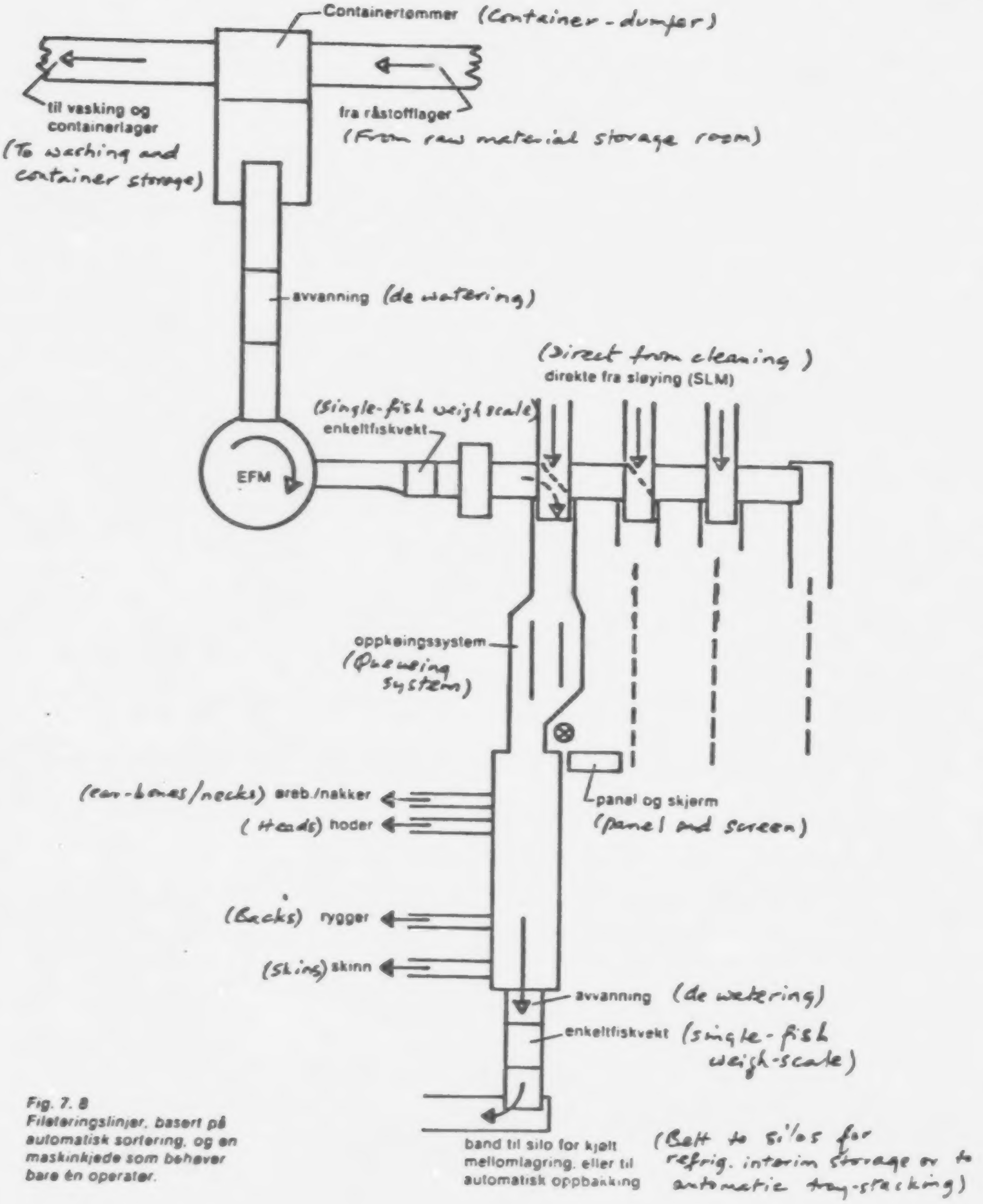
Containertømmer (Container-dumper)
til vasking og containerlager
(To washing and container storage)
fra råstofflager
(From raw material storage room)
avvanning (de watering)
(Direct from cleaning)
direkte fra sløying (SLM)
(Single-fish weigh scale)
enkeltfiskvekt
EFM
oppkøingssystem
(Queueing system)
panel og skjerm
(panel and screen)
(ear-bones/necks) øreb./nakker
(Heads) hoder
(Backs) rygger
(Skins) skinn
avvanning (de watering)
enkeltfiskvekt (single-fish weigh-scale)
band til silo for kjølt mellomlagring, eller til automatisk oppbakking
(Belt to silos for refrig. interim storage or to automatic tray-stacking)

Fig. 7. 8
Fileteringslinjer, basert på automatisk sortering, og en maskinkjede som behøver bare én operatør.

Figure 7.8 Filleting lines, based on automatic sorting, and a machine chain that needs only one operator.

8.1 Raw material for fish pulp

8.1.1 Fish pulp from the thick fish bone cut*, the ear-bone / necks, and the fin-bone

Nowadays, fish pulp is usually produced from two types of raw material, namely from the thick fish bone cut (V-cut) and from ear-bones / necks. The former, which does not require prior washing yields a first-class fish pulp. Fish pulp made from the ear-bones is of poorer quality. The ear-bones / necks must be washed prior to being separated, and often the pulp must be washed as well. The problem in this case is to achieve a "proper" de-watering. The hygienic problems involved with respect to fish pulp from ear-bones / necks are intensified because of the batch mode of the separator. This means that the raw material is often kept standing for a while in quite high temperatures, causing a considerable growth in bacterial contamination.

As mentioned in section 7.3.1, filleting machines exist which have mounted on them a unit which cuts away the fin-bone (and the flesh around it). This should represent a raw material of similar quality of that from the thick fish bone cut. Such a cutting-away system may also be delivered as an independent machine unit. Fig. 8.1. shows how the fin-bones are cut away from the back bone.

8.1.2 Fish pulp from heads and back-bones

Some experiments have been conducted on separating the meat from heads (Frionor) after these have been crushed in a roller-mill.

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*Literal translation

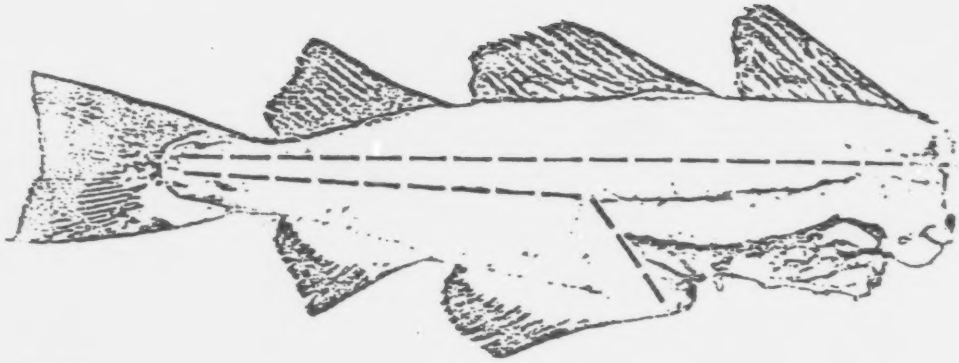

Fig. 8. 1
Skisse av snitt for utskjæring av finnebein.

Figure 8.1 Sketch of the cut used for cutting away the fin-bone.

During the crushing process, the eyeballs are punctured and the dark liquid inside is released. The crushed pulp is flushed with water and dewatered prior to the separation. This approach results in a relatively high-quality product which is comparable to fish pulp from the ear-bones. The yield of fish pulp as a proportion of head weight was was approximately 20%. This was a small-scale experiment, however. If specially developed equipment for this operation is used (e.g. mills, crushing drums, or "chopping machines") prior to the separation process, it would be quite possible to increase the yield as high as 30 - 40%, the theoretical limit being approx. 65% (cod). These percentage figures were calculated on the basis of heads plus gills. It would be a benefit if the gills were removed prior to separating. In order to obtain a lighter fish pulp, mechanical washing and dewatering can be used, but this could lead to problems with losses of water-soluble proteins and fish pulp bits. It is possible that washing and mechanical dewatering of the the chopped-up head pulp would be sufficient. In cases where heads from long-line fishing operations are to be used for fish pulp, and the "remainder" for animal feed. the head must be passed through a metal detector, or the like. More recent experiments (FTFI) show that the brain mass creates large problems in that it is too fluid. Using existing equipment, it was impossible to extract the water. This is a problem that must be resolved if fish heads are to become a viable raw material for fish pulp production.

The back-bone represents a viable raw material. It is assumed that the back-bone must be finely ground or chopped prior to separation. The problem in using back-bones as raw materials is the presence of the

(48) kidney vascular network (blood vessels), which lie between the spinal column and the swim-bladder. This kidney network contains an enzyme which causes a chemical reaction in fish muscle tissue: (TMA - 0 - $\xrightarrow{\text{enzyme}}$ DMA + FA). One of the products of this reaction (FA) reacts with the protein in fish muscle tissue to give an unpleasant texture, making it of little use as raw mateial for edible fish products. (TMA - 0 = trimethylamine oxide, DMA = dimethylamine, FA = formalin).

This texture change occurs when the raw material is freeze-stored if the kidney vascular network is present. The reaction rate is reduced by lowering the storage temperature.

Three methods are conceivable for dealing with this problem.

- Send the fish pulp right away, while still fresh, to the cooking plant. Warm temperatures destroy the enzyme. The finished product is then hermetically sealed. This approach requires large capacity.
- Mechanical removal of the kidney vascular network prior to chopping and separating. The question is whether effective equipment can developed for this job. Equipment that is attachable to the SLM might be feasible.
- Removal of the kidney network in the fish pulp washing stage. If enough of the kidney network is removable in this way, then this is, in fact, technically possible using present-day equipment. The question is still whether washing of the pulp is sufficient to remove the kidney network.

Rancidity due to the precence of blood traces is also a problem.

It should be investigated whether the solid material found in the wash water from the filleting lines, together with other waters which were not in contact with the floor (or are contaminated in any other way) may be used for fish pulp.

It is also conceivable that the bones can be fine-ground and included in the fish pulp as they can contribute considerably to the nutritional value.

(49) 8.2 Production techniques and equipment, further processing of fish pulp

8.2.1 Separating

Breaking / chopping / coarse-grinding of the portions with the most bones (ear-bones, heads, and back-bones) can be carried out using roller mills, chopping machines, and crushing drums.

For the separation of meat from the bones, various types of drum separators are used.

In some types of machinery, crushing drums / roller mills are mounted in front of the separator.

8.2.2 Washing of raw materials and fish pulp

In the case of raw materials which require washing, this can take place prior to separating, but after breaking / chopping, coarse-grinding, or even after separating. The types of raw material which must be washed only before separating are: ear-bones, fin-bones, heads, backs with kidney vascular network removed (blood vessels). The thick-fish bone cut must not be washed either before or after separating.

Fish pulp from backs with kidney network attached must be washed. Washing seems to remove most of the TMA - O in the fish muscle tissue (it is water-soluble), as well as some of the network itself, so it is possible that this would be enough to stop the reaction which results in the textural change in the fish muscle tissue. How much washing is necessary, from a colour or storage stability point of view, is something that must be investigated further. Washing of fish pulp will also, as mentioned above, lead to yield losses and loss of water-soluble proteins.

For washing larger bits (e.g. ear-bones), a vertical, rotating drum is often used. This drum is run using batch loads. Also used is a "washing bin" which uses mechanical conveyors for removing the material. Such a washing system can be run continously.

Horizontal drums, partly submerged in water, or equipped with water spraying devices are also used. Such drums are attached to conveyors, so that removal is automatic, and the drum can thus be continously fed.

For washing fish pulp, horizontally lying drums equipped with cross-spraying equipment can be used. The pulp is removed by conveyors and so the washing drum can be fed continuously. It is also a possibility to wash the pulp using a flotation technique. Fat, bits of skin, and other light particles attach themselves to the air bubbles, float up to the surface, and are scraped off. Fish particles sink to the bottom and are pumped out. Flotation washing would be a continuous process.

8.2.3 Dewatering

For dewatering of the larger bits, it is perhaps possible that a fall from one sieving plate to another (with air blown onto them) would be sufficient. Screw presses may also be used, as well as a perforated horizontal drum with conveyors (a type of rotating sieve). All these 3 methods are continuous. It should also be investigated
(50) whether some form of vertical centrifuge could be used. This, however, would be best suited for batch operations.

For dewatering fish pulp, both screw presses and filter presses are used nowadays. Both methods use a continuous feed process. A continuous centrifuge decanter may also be feasible.

Stringent specifications regarding quality and water content in fish pulps must be brought into effect, so that the equipment producers are aware of what their equipment has to be suitable for. The drawing up of these specifications must be done in co-operation with market agencies such as Frionor, for example.

8.2.4 Products from fish pulp

The traditional method of processing fish pulp is to package the pulp in blocks and these blocks are then used in the finished product production, for instance, for fish-cakes and fish-sticks aimed at special markets. There is little that a fish processing plant can do by itself to refine the pulp if there is no finishing plant available.

The trend in Norway appears to be toward the concentrating of finished product production in a few plants to which the other plants ship their partially refined goods. This is due in part to large investment costs necessary in plants having high production capacity.

A more efficient use of the fish pulp in some plants is achieved when it is mixed into the fillet blocks. This is with the assumption that a higher total price would then be received. Fish-sticks produced from such blocks are of similar quality to those produced from pure fillets, at least, the differences are so small as to be imperceptible to the average consumer. Such a production approach requires careful production planning. Equipment to provide a satisfactory mixture of fish pulp and fillet is available on the market. Such equipment can relatively easily be incorporated into a continuous flow packing line, for example, utilizing semi-automatic proportioning. Several types of automatic proportioning / packing machines are available, which would be useable also for packing fish pulp.

To what extent individual plants can move into finished production of fish pulp, in the form of various oven-ready fish products, must be investigated further. It is conceivable that several smaller plants can conbine to operate a central finishing plant.

As the above discussion indicates, too little is presently known to allow the setting up of optimum-efficiency lines for the production of fish pulp from the various fish-portions available, or from whole fish (e.g. blue whiting, trash herring, capelin, etc.).

What can be said with certainty, however, is that strict control must be exerted on hygiene, and that all intermediate storage of the raw material and the fish pulp must be done in refrigerated areas. It is also possible that the pulp production itself could be carried out in refrigerated areas. The production must be made into an integrated part of the total production effort of the plant, and must no longer consist of one separating machine stuck in a corner of one or the other production areas.

(51) 9. PRODUCTION OF ANIMAL FEED, INCLUDING FREEZER PACKAGING

9.1 Raw materials for animal feed

Raw material commonly used for animal feed are: backs, skins and waste product from the washing tables (lines). In the case of some operations, ear-bones / necks are used; in others, ground-up heads.

When, as expected, all the ear-bones / necks, backs, and heads become used for fish pulp, there will be much less animal feed produced. Animal feed can then be made from skins, wastes from the washing process and from fish pulp production, as well as those ear-bones / necks, backs, and heads which cannot be used for fish pulp. In addition, all the solid material recovered from the drain water (less that which is useable for fish pulp) can also be considered.

9.2 Production methods and equipment

9.2.1 Freezing in tunnels

Generally, animal feed materials are held in trays, and the trays are placed in freezer tunnels for freezing over-night. This will save on electricity costs in that day-time peak electricity rates are thus avoided. In addition, such a procedure fits in well with the normal work routine. On the following day, the trays are taken out from the freezer tunnels and emptied, and the frozen blocks are placed inside the cold storage room.

Removal from the trays takes place with the aid of warm water and, in the worst cases, breaking tools. This job is not particularly attractive and demands a complete upgrading. The animal food blocks are very large, with uneven undersides, and as a result are difficult to store efficiently. In order to store the animal feed blocks in high stacks in the cold storage room a kind of pallet with side walls can be used.

An improvement of this production technique might consist of developing a type of tray and ejection equipment, so that the ejection of the blocks can be done mechanically.

If the use of warm water is necessary, then this can occur in the form of enclosed spraying installations. If there is a good supply of lukewarm water, the water spraying can be sufficient to loosen up the blocks. In order to achieve a better stowing efficiency, it might be desirable to coarse-grind the animal feed.

9.2.2 Freezing in vertical plate-freezers

Animal feed production systems exist that are based on grinding mills, silos, and vertical plate freezers. The electricity consumption will be somewhat higher in such a system, however, because of initial freezing taking place during the day.

Some installations exist in which the waste products are brought in in gutters below floor level, using flowing water as the transport medium, and stored in a tank. From this tank the wastes are taken by mechanical carriers up to the grinding mills, where a continuous grinding takes place. Following the grinding process, the animal feed goes to the silos, and then through tubing up to the vertical plate freezers. These have a freezing time of 2 - 2.5 hours.

(52) The only manual work involved are the control of the tubes during the filling of the plate freezers, and the lifting out of the frozen blocks (the plates are pulled slightly apart from each other and the bottom of the freezers is lifted up, so that the blocks are accessible). This is a cold and relatively hard job, and mechanical equipment for lifting out the blocks should be developed. Horizontal plate freezers are now available on the market whose bottoms are designed in the form of a drop-hatch (trap-door). When the plates are pulled apart from each other and the bottom opened, the blocks can exit beneath the freezers.

The vertical plate freezers may also be used for whole-freezing of fillet raw material, herring, mackerel, blue whiting, etc.

9.2.1 Ensilage

In recent years, a method for ensiling fish entrails has been developed. The protein-rich water phase is mixed in the following proportions: 55% water phase, 20% heads or filleting scraps (ground up), 10% grass-flour, along with 15% barley. This feed composition is called "Kleivafor" and is used as food for house pets.

Alternatively, the water phase can be evaporated (concentrated) and added as a protein source in standard feed concentrates. Experiments will also be carried out on ensilage of other parts of the fish, such as backs and heads. This would therefore represent an alternative usage for this resource.

Ensilage of heads from fish taken using long lines makes economic sense as these parts can be used without going through a metal detector. During the ensilage process, the hooks come free and are left at the bottom of the bin as a waste product to be disposed of.

9.3 Lines for the production of animal feed

9.3.1 Production line, Option 1 (Fig. 9.1)

This arrangement is the traditional one, using tunnels for freezing. Since the animal feed is produced from backs and heads, the raw material is in a coarse-ground state. A specially-designed filler apparatus is used, thus avoiding any mess or spills. There is also a linear cylinder for spraying the trays with warm water and possibly having a mechanical means of ejecting the blocks.

9.3.2 Production line, Option 2 (Fig. 9.2)

This system is based on the use of crushing mills, silos, and vertical plate freezers. Both filling and removal of the frozen blocks is done manually.

9.3.3 Production line, Option 3 (fig. 9.3)

This is as in section 9.3.2, but with automatically controlled filling, mechanical unloading from the plate-freezers, and mechanical

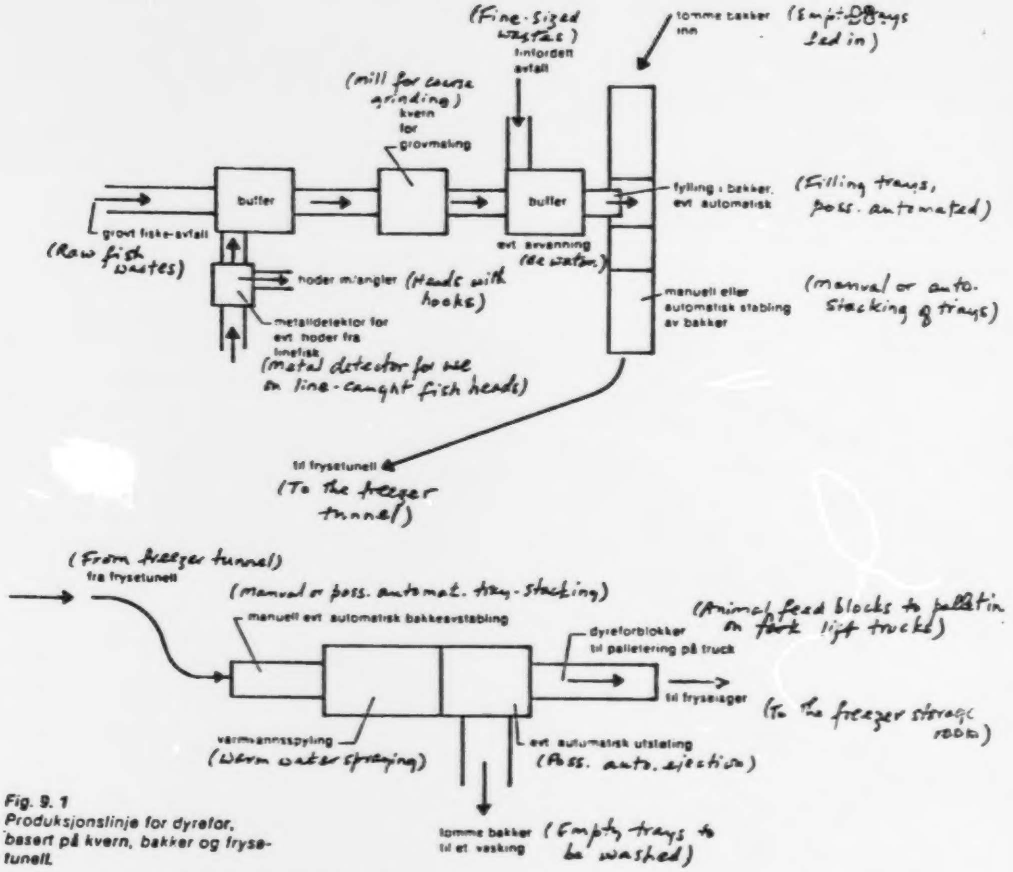
(Fine-sized wastes)
finfordelt avfall
tomme bakker inn
(Empty trays fed in)
(mill for course grinding)
kvern for grovmaling
buffer
buffer
fylling i bakker, evt automatisk
(Filling trays, poss. automated)
grovt fiske-avfall
(Raw fish wastes)
evt avvanning
(de water)
hoder m/angler
(Heads with hooks)
manuell eller automatisk stabling av bakker
(manual or auto. stacking of trays)
metalldetektor for evt hoder fra linefisk
(metal detector for use on line-caught fish heads)
til frysetunell
(To the freezer tunnel)
(From freezer tunnel)
fra frysetunell
(manual or poss. automat. tray-stacking)
manuell evt automatisk bakkeavstabling
(Animal feed blocks to palletin on fork lift trucks)
dyreforblokker til palletering på truck
til fryselager
(To the freezer storage room)
varmvannsspyling
(Warm water spraying)
evt automatisk utstøting
(Poss. auto. ejection)
tomme bakker til et vasking
(Empty trays to be washed)

Fig. 9. 1
Produksjonslinje for dyrefor, basert på kvern, bakker og frysetunell.

(Production lines for animal feed based on mills, trays, and freezer tunnels)

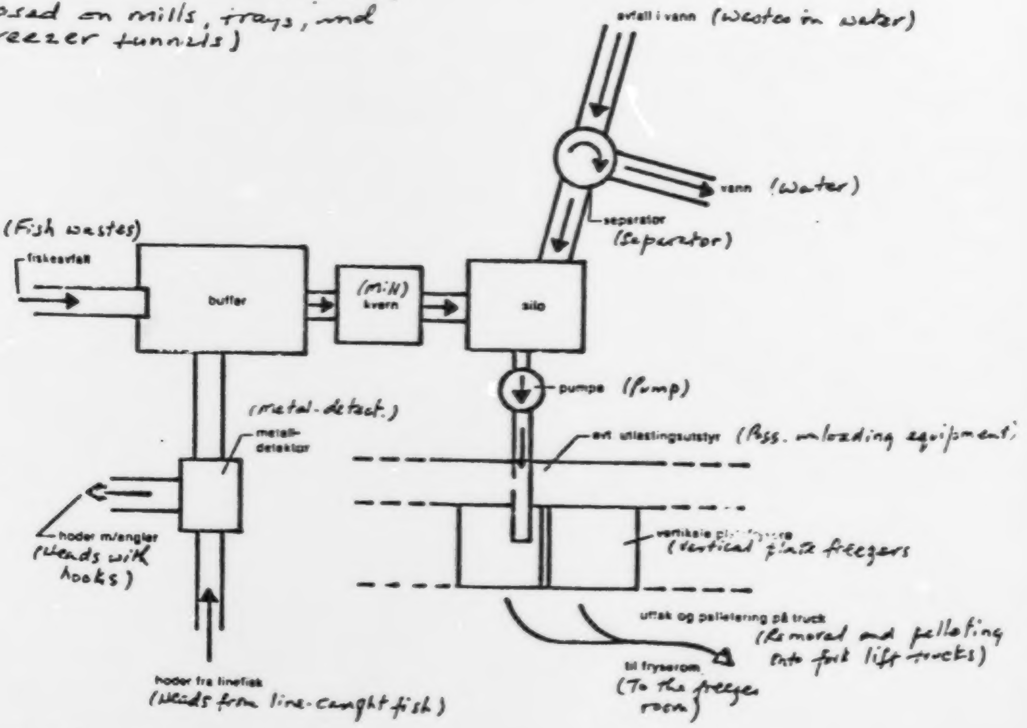

Fig. 9. 2
Produksjonslinje for dyrefor, basert på kvern og vertikale platefrysere.

(Production line for animal feed, based on mills and vert. plate freezers)

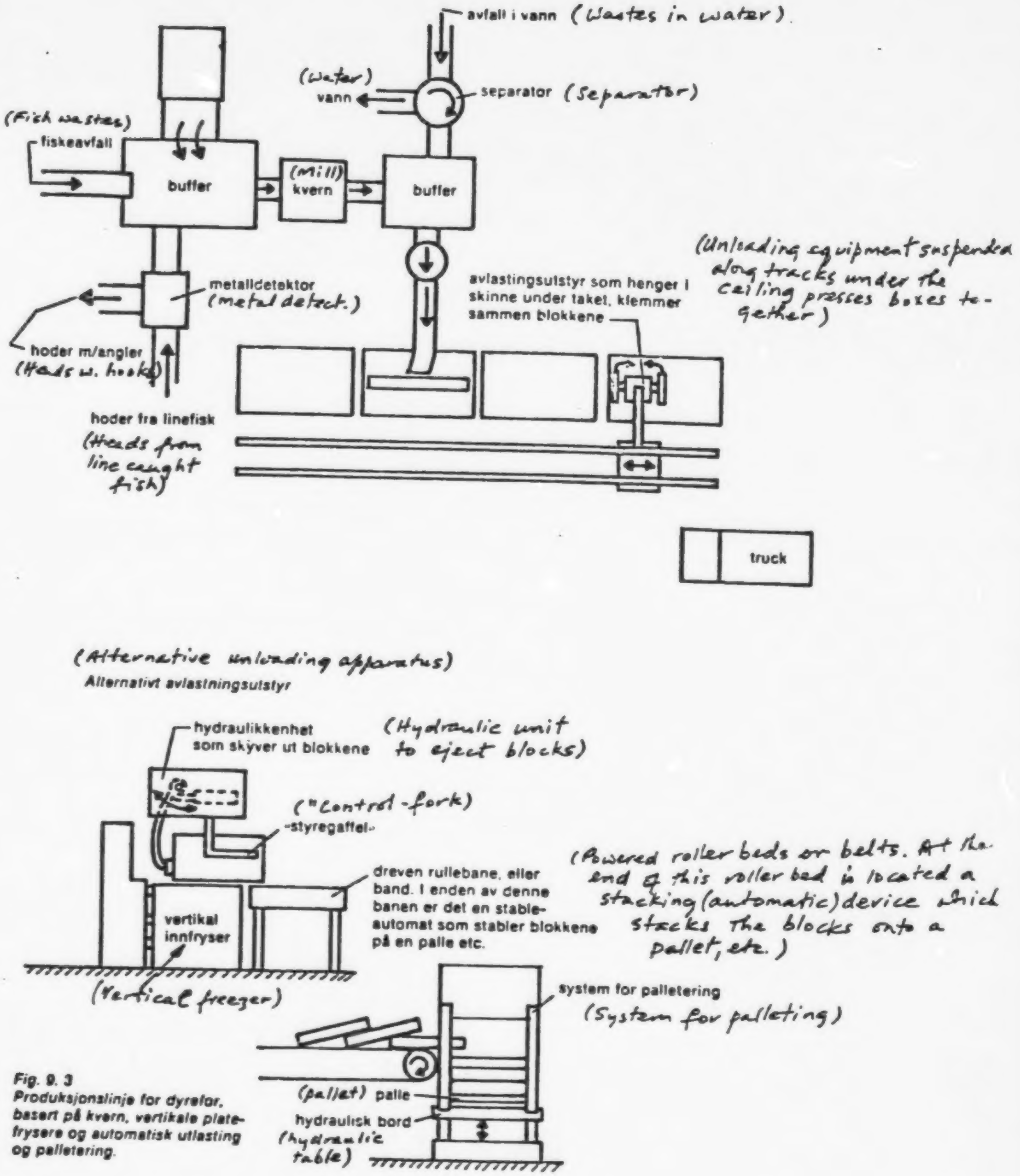
avfall i vann (Wastes in water)
(Water) vann
separator (Separator)
(Fish wastes) fiskeavfall
buffer
(Mill) kvern
buffer
metalldetektor (metal detect.)
hoder m/angler (Heads w. hooks)
hoder fra linefisk (Heads from line caught fish)
avlastingsutstyr som henger i skinne under taket, klemmer sammen blokkene
(Unloading equipment suspended along tracks under the ceiling presses boxes together)
truck
(Alternative unloading apparatus)
Alternativt avlastningsutstyr
hydraulikkenhet som skyver ut blokkene
(Hydraulic unit to eject blocks)
("Control-fork)
-styregaffel-
dreven rullebane, eller band. I enden av denne banen er det en stable-automat som stabler blokkene på en palle etc.
(Powered roller beds or belts. At the end of this roller bed is located a stacking (automatic) device which stacks the blocks onto a pallet, etc.)
vertikal innfryser
(Vertical freezer)
system for palletering
(System for palleting)
(pallet) palle
hydraulisk bord
(hydraulic table)

Fig. 9. 3
Produksjonslinje for dyrefor, basert på kvern, vertikale platefrysere og automatisk utlasting og palletering.

Figure 9.3 Production line for animal feed, based on mills, vertical plate freezers, and automatic off-loading and palleting.

stacking on pallets. This line can be run in a completely automatic manner.

The automatic equipment sketched in this case is really aimed at those installations using standard, vertical freezers. The plants planning to acquire new vertical plate-freezers should cnsider those types where the blocks are taken out through the bottom (the "Fallem principle").

(55) 10. MAINTAINING REFRIGERATED CONDITONS BETWEEN THE VARIOUS PRODUCTION UNITS.

10.1 The arguments in favour of regrigerated interim storage

Because of the differences in capacities between the filleting and clean-cutting / portioning sections, uncleaned fillets will crop up from time to time in the filleting room. The through-time from the raw material store room to the freeze packaging process should not exceed 1 hour at 18 - 20^{o}C. For this reason, the need exists for refrigerated interim storage between the cutting room and the filleting room. This storage facility must operate on a first in / first out principle. The same storage facility may also be used for storage of fish pulp raw materials and for interim storage prior to freeze-packaging.

The following benefits would result from the use of such a storage space:

- normal working temperatures could then be allowed in the production areas;
- improved capacity utilization would result, through the fact that the various sections would be able to operate independently of each

other. Fillets destined for the housewife shopping shift, for example, could then be cut up during normal working hours;

- less temperature increase in the fillets and thus, better quality control;
- reduced loss of fish body fluids during freeze packaging, thus reducing the amount of overweight allowance in every package. In the case of fillets from frozen raw materials (whole-fish freezing), it is especially important to maintain low temperatures;
- energy is saved in the freezer packaging process. This would not amount to very much, however, since it costs about 80 times more to freeze 1 kg of fillet (at slightly below 0^oC) than to cool it down by 1^oC at temperatures over 0^oC;
- the storage space will reduce the amount of noise transferred from the cutting room to the filleting room.

10.2 Design of the storage space

Such a storage space may be designed in various ways depending on the transport method used between the cutting and the filleting rooms. The methods in use today are:

- The fillets are transported in trays on trolley carts.
- The trays holding fillets are moved using powered roller-beds, or with the aid of chain-drives.
- Single fillets are transported on conveyor belts.

The two latter methods may be used in association with an automatic storage system.

10.1.1 Design of the storage space, Option 1 (Fig. 10.1)

This system is based on stacks of trays being placed inside the space. The trays are filled and stacked. This may be done either manually or automatically. The weighing process would take place in conjunction with yield control and could be carried out at a central weigh-station, or possibly, at an automatic filling system.

(56) The trays are stacked 5 - 10 high. The tray stack is transported through the weigh-scales using a special trolley carts and into the storage area, where they remain until the fillets are taken in for washing, etc. In the filleting room either manual or automatic tray stacking may be used.

10.1.2 Design of the storage space, Option 2 (Fig. 10.2)

This option involves automatic filling of the trays. The trays are placed on a weigh-scale, and the precise weight is recorded in a computer. The filled trays are then stacked automatically and when a pre-specified number has been reached, the tray-stack is pushed out on to a roller-bed buffer area.

The stacks of trays are thus transported as far as the storage space. The storage space consists of inclined roller-beds, in which forward feeding occurs by gravity. The storage space may be "managed" in such a way that the roller-beds are filled from left to right, for example, and are emptied in the same order.

Removal takes place with the aid of trolley carts which transport the tray stacks to the tray unloader.

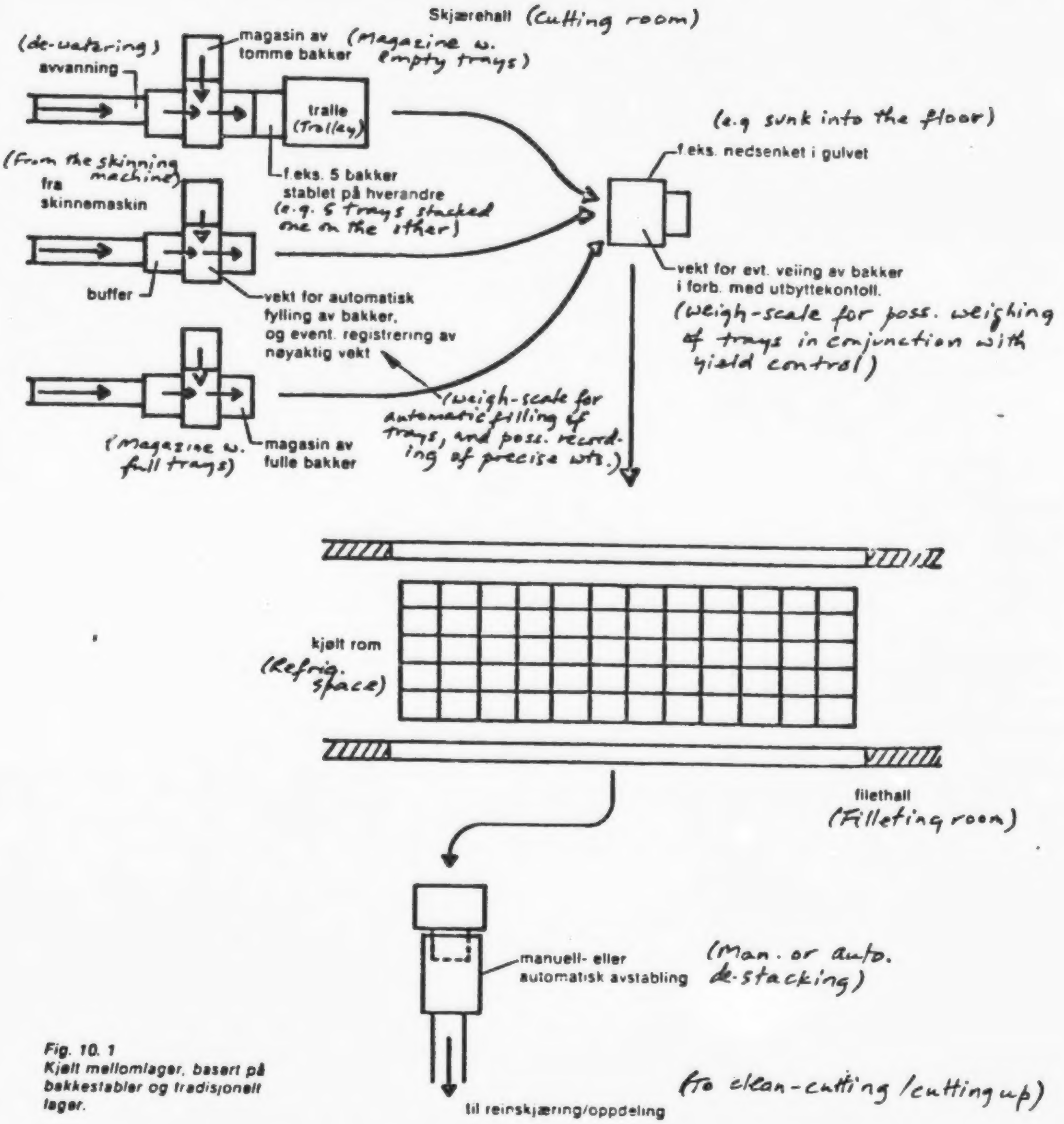
Skjærehall (Cutting room)
(de-watering)
avvanning
magasin av tomme bakker
(Magazine w. empty trays)
tralle (Trolley)
(e.g sunk into the floor)
f.eks. nedsenket i gulvet
(From the skinning machine)
fra skinnemaskin
f.eks. 5 bakker stablet på hverandre
(e.g. 5 trays stacked one on the other)
vekt for evt. veiing av bakker i forb. med utbyttekontoll.
(weigh-scale for poss. weighing of trays in conjunction with yield control)
buffer
vekt for automatisk fylling av bakker, og event. registrering av nøyaktig vekt
(weigh-scale for automatic filling of trays, and poss. recording of precise wts.)
(Magazine w. full trays)
magasin av fulle bakker
kjølt rom
(Refrig. space)
filethall
(Filleting room)
manuell- eller automatisk avstabling
(Man. or auto. de-stacking)
til reinskjæring/oppdeling
(To clean-cutting/cutting up)

Fig. 10. 1
Kjølt mellomlager, basert på bakkestabler og tradisjonelt lager.

Figure 10.1 Refrigerated interim storage space, based on tray stackers and traditional means of storage.

(Figure 10.2)

(57) 10.2.3 Design of the storage space, Option 3 (Fig. 10.3 and 10.4)

This storage space is completely automatic and both depositing and removal is computer-controlled. Three proposals are presented below for the design of such a storage space.

Two of the proposals are based on the trays with fillets being transported on powered roller-beds to and from the storage space. In-filling and stacking of the trays are carried out as in Option 2. The storage space itself can consist of inclined roller-beds (Fig. 10.3) as in Option 2, or of a conveyor-belt / roller-bed arrangement (Fig. 10.4).

In the latter case, transport into the storage space is more rapid than transport out, with diminishing speed inside the storage space from one conveyor-belt / roller-bed system to the other. Because of this, the tray-stacks tend to "squeeze together". Outbound removal rate and thus, the speed of flow inside the storage space, is automatically controlled by the capacity inside the filleting room. The removal
(58) process can also be controlled "manually" with the aid of push buttons.

In the third system, fillets are transported by conveyor-belt over to the storage space where they are stored in a kind of "silo system". This ensures that the first lot in is the first out. The silo(s) must not contribute to damage to the fish fillets due to large overhead weight resting on the bottom pieces. The amount of fillets coming from the various filleting lines is recorded with the help of single-fish weighing systems. This weighing technique can be used as an alternative in the systems shown in Fig. 10.3 and 10.4.

(Figure 10.3)

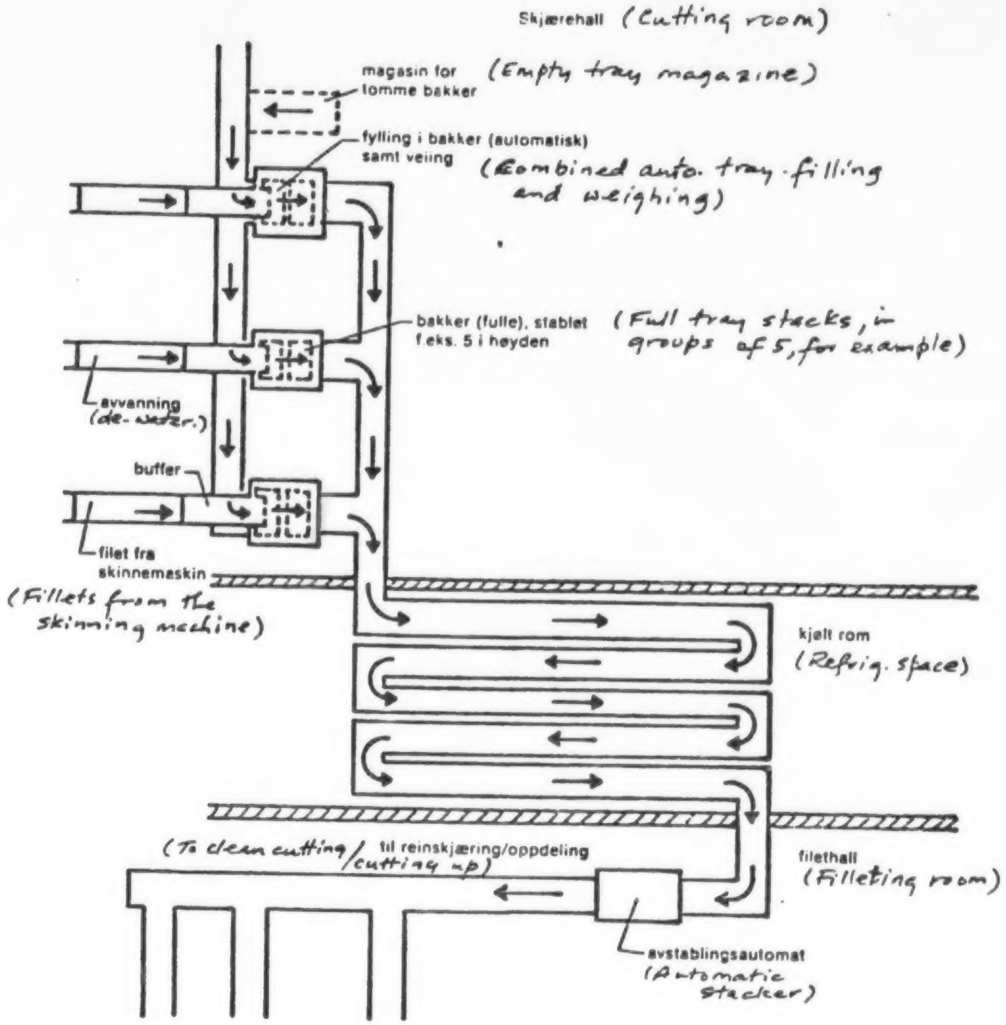
Skjærehall (Cutting room)
magasin for tomme bakker (Empty tray magazine)
fylling i bakker (automatisk) samt veiing (Combined auto. tray-filling and weighing)
bakker (fulle), stablet f.eks. 5 i høyden (Full tray stacks, in groups of 5, for example)
avvanning (de-water.)
buffer
filet fra skinnemaskin (Fillets from the skinning machine)
kjølt rom (Refrig. space)
til reinskjæring/oppdeling (To clean cutting/cutting up)
filethall (Filleting room)
avstablingsautomat (Automatic stacker)

Fig. 10. 4
Kjølt mellomlager basert på bakkestabler, drevne rullebaner og «bandlager/dreven rullebanelager».

Figure 10.4 Refrigerated interim storage space, based on tray-stackers, powered roller-beds, and conveyor-belt or powered roller-bed type of storage arrangement.

The weighing systems shown in Fig. 10.1, 10.2, 10.3, and 10.4 vary to some degree,in detail, from the systems shown in Fig. 7.3, 7.4, 7.5, 7.6, 7.7, and 7.8. In those cases where a precise weighing occurs during the tray-filling process (Fig. 10.2, 10.3, and 10. 4), it is not necessary to have a batch weighing step following the skinning machine (Fig. 7.7, for example).

(60) 11. CUTTING-UP / PORTIONING, WEIGHING, AND PACKAGING

11.1 Eventual use of fish fillets

The washed, finished fillet is used either in the manufacture of consumer packages or in semi-manufactured products, such as blocks. A stricter freshness standard has been set for the material destined for consumer packages, but the criteria on which quality is determined are vague and imprecise.

Certain markets accept consumer fillets sawn from blocks, while others desire products that are as natural as possible. A large number of variations are to be found based on perceptions of the average consumer wants, and on preferences of large retailers. Depending on the quality and size of the fish, a single fillet may be cut into 3 to 4 pieces, and each piece could go to various product variants. A well run installation would make use of this to the optimum, but its use is conditional on whether the installation has a flexible production system and a good production management which incorporates economical production management in its operations. Due to the high temperatures common in the filleting room, the production flow in this room must ensure that through-time is as short as possible.

11.2 Work and transport operations within the filleting room

11.2.1 Work operations

a. The fillet is rinsed free of bones, dark membranes, blood extravasation, intestinal worms, oxidized or tainted parts, etc.

b. It is then divided into suitable pieces according to end-use

c. The finished fillet pieces are portioned into the specified weights, depending on the product type involved.

d. The fillet pieces are placed in boxes and the boxes are closed.

e. The boxes are placed into freezer frames. Boxes within the freezer frames can then be subjected to vacuum.

f. Quality control checks are made of the fillets after the rinsing step. In addition, fillets are weighed in order to record the production and yield for each operator and / or group of operators.

These work operations can thus be combined in various ways.

11.2.2 Transport operations

These consist of:

- Transport of fillets in from the cutting room, through the refrigerated interim storage space, if such exists
- Transport between the various work stations
- Transport of finished goods to interim storage / freezing. This takes place using a shelved cart holding the freezer frames / trays containing the goods.

(61) As mentioned previously, the 2 former transport operations can be done using the following methods:

- The fillets are transported in trays which are stacked up on trolley carts
- The fillets are transported in trays on roller-beds, or a chain-drive system
- The fillets are transported singly by conveyor belt

Transport using trays leads to the need for a large number of trays and much handling, cleaning, and storing of these. Trays transported on roller-beds can result in increased noise levels, if the choice of materials used is inappropriate. Maintaining sanitary conditions is relatively straightforward when trays are used.

Transport of fillets by conveyor belt may result in difficulties insofar as cleaning of the belts is concerned. Some losses of raw material may also occur due to the mechanical handling each single fillet is subjected to. The main benefit of this approach is that use of trays is avoided as well as the other equipment and handling operations that trays involve.

The particular set-up a plant decides to use with respect to work and transport operations will vary considerably from plant to plant. These can be completely specialized systems, in which the operator has only a single work operation to perform and in which a correspondingly greater transport is involved. At the other extreme is the compound systems, in which the operator carries out a number of operations as well as control. It is impossible to say which arrangement will generally be the best-suited, since this depends on the perceptions of plant owners / management and the workers, as well as the constraint framework exerted by the buildings, etc. The type of labour contracts in use at each plant also has much to do with how the work at that plant is organized.

11.3 Mechanizing and automation in the filleting room

The following section deals with the possibilities for mechanization and automation of the various work and transport operations in the filleting room.

11.3.1 Mechanization of the clean-cutting / sub-dividing operations

These two work operations are extremely difficult to mechanize. Experiments have been conducted into the use of a machine which cuts out the thick-fish bone from the fillet. Since every single fillet must also be handled in the rinsing out of other "impurities", we can only conclude that clean-cutting and portioning will continue to be labour-intensive operations. Optical systems to monitor the washed fillets are also a possibility.

In order to obtain the best possible economic returns, it is important that a precise sub-division and maximum utilization of the fillets is carried out. The operators on the cutting lines / tables should monitor carefully the quality of the fillets and decide on the type of products they are ultimately destined for. This demands a flexible production arrangement which permits concurrent packing of several product variants.

If straight salary agreements or joint contracts for large groups of workers are instituted, the need for weighing of the production quantity of each individual operator will be unnecessary. However, weighing must take place in order to monitor the yield figures.

(62) 11.3.2 Mechanization of the portioning, packaging, sealing of fillet packs, and depositing in the freezer frame.

These work operations should be amenable to mechanization and automation. The most difficult to mechanize / automate would be the placing of the fillets in boxes (packaging). Strict specifications apply to how packaging is carried out. In order for mechanical packaging to be in any way possible, some liberalizing in these packaging specifications must occur.

Because of the inherent properties of fillets, they are not very amenable to mechanical handling. They are moist, soft, and have a high friction effect against plastic foil, and the like. Furthermore, they come apart very easily. It is therefore conceivable that packaging of consumer-type (cut-up) fillets would be easier to mechanize than that of blocks (often whole fillets). If the blocks are to be packed in "random order" packaging them would probably be just as difficult.

If single-freezing[*] of fillets can be justified on economic / capacity grounds relative to contact freezing[*], then single-freezing can possibly be considered as a viable freezing method. Such an approach would make mechanical packaging easier, even though it would result in more voluminous packages.

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[*] Literal translation

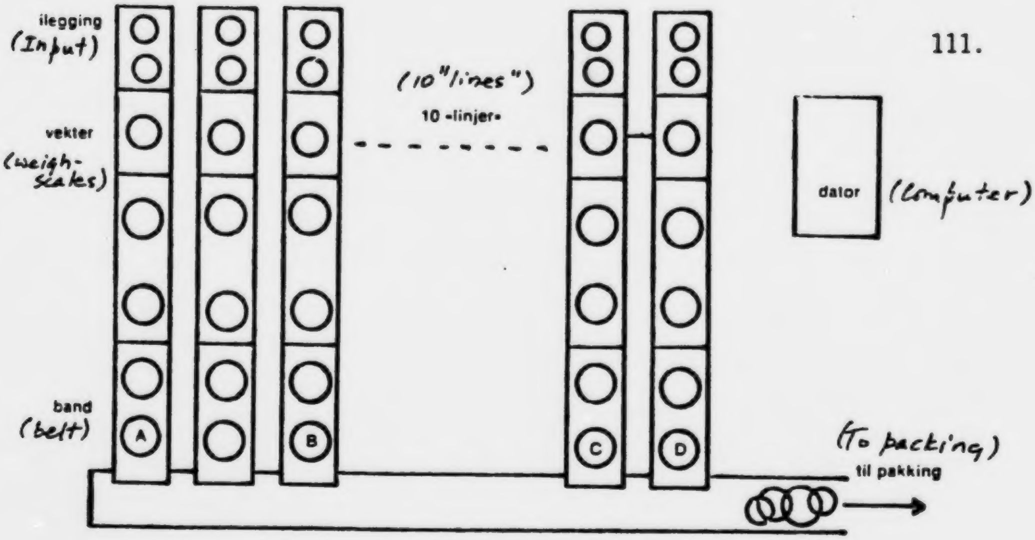
Detailed investigations should be carried out regarding whether single-freezing is the approach to take. In the analysis, factors related to capacity and economic aspects, such as portioning, packaging, freezing, storage volumes required, crating, and transport must be taken into account.

Currently, there are systems available which are mechanized and automated to a greater or lesser degree:

- Automatic wrapping and relaying of the boxes, as well as sealing of the boxes. Portioning, loading into the boxes, and placing the boxes in freezer frames are done manually. These systems require a large production volume in order to be profitable.
- The most rational method in current use for producing consumer-market packs is to package whole fillets in blocks and to freeze and store these. The blocks are later taken out of storage and sent for processing. Sub-division (sawing) of these blocks, placement in boxes, closing and glueing of the box seal tabs are completely mechanized. Only a minor step prevents such a method from becoming an integrated automated process. The same blocks can be used in the production of fish-sticks, fish croquettes, etc. Automatic equipment is also available for this process as well.
- Package-filling by volume and check weighing and adjustment of the weights of those packages that are outside the acceptable range.

I will go on to mention recognized methods that are presently available, but whicch are not in use in the Norwegian fish-processing industry. The methods concern only the portioning (weighing) and not the packaging process.

- Experiments were carried out on an extrusion device for fish sticks, using automated portioning by volume. This machine is, at the moment, not available on the market, possibly mainly because of its (63) too low capacity. The idea, nevertheless, is a good one and should be developed further. The packaging process, in the event such a machine is used, would be simple to automate.
- Individual weights, i.e. package-filling by volume, and pricing each package separately.
- Permutation weighing. This system exists, and is in use, in England, for instance (Fig. 11.1). The system consists of 10 lines which are fed manually. Each line has a controlled forward flow from position to position. Position number 3 (shown in the diagram) is a weighing device. This weigh-scale records the precise weight for each piece that passes along each line. A computer stores the weight and location of each piece on the lines. In this manner, a rapid calculation can be done to obtain a combination of pieces which falls close to the desired weight, for example 400 grams, on the higher side. When these pieces are found (in this case, pieces A,B,C, and D), they are driven out on small conveyor belts for packaging. The small conveyors can be operated in such a way that the pieces are deposited together on the transverse belt. The authors can verify that this system was both fast and accurate.



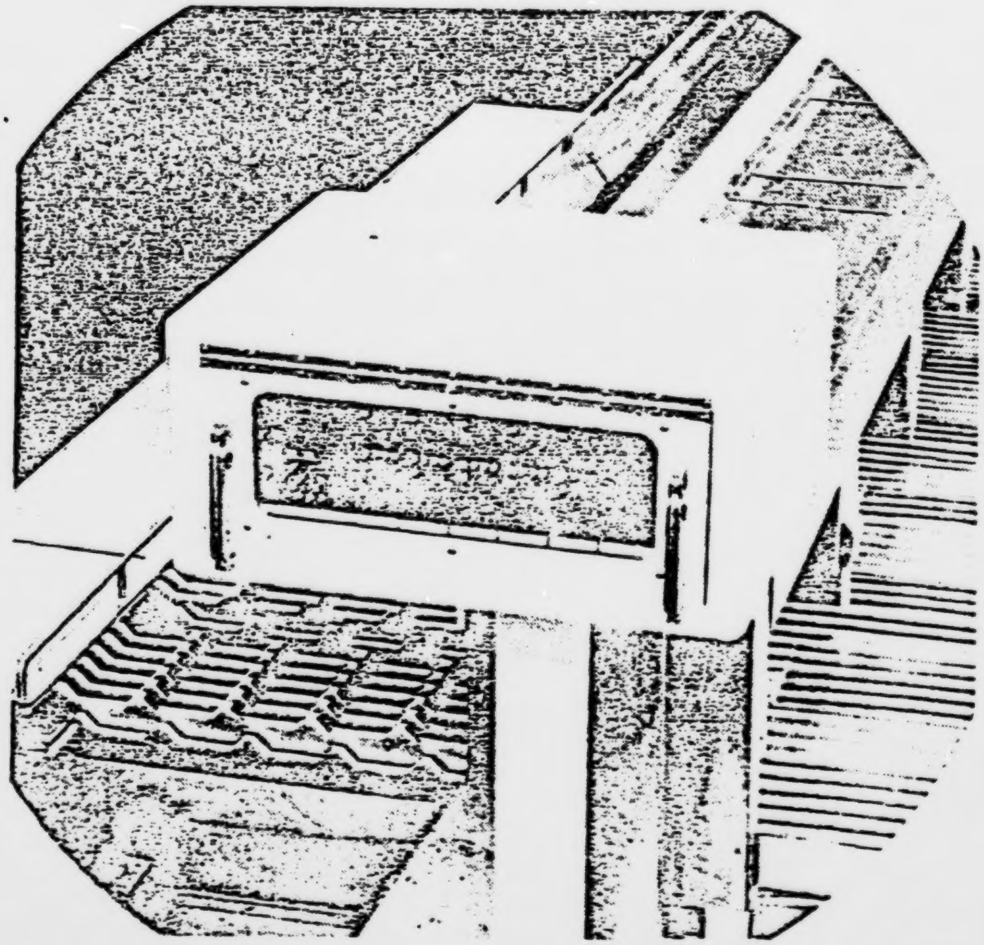


Fig. 11. 1
Permuterende veieautomat (Permutating automatic weighing system)

For mechanical handling of trays, including out-bound flow control from the roller-beds, as well as stacking and unstacking, equipment is available which easily meet the demands of the fish-processing industry.

Installation of freezer frames and vacuum systems can readily be mechanized and automated on the basis of current technology.

11.4 Production lines for portioning / packaging

In this section, the clean-cutting / sub-division lines / tables will not be considered because of the many possible arrangements that exist for these.

11.4.1 Portioning / packaging lines, Option 1

The system is based on manual or mechanical packaging of block-type units. Frozen blocks are used in automatic sub-division for consumer-destined packages, while wrapping and closing / glueing of box tabs is carried out in an automated fashion.

Another alternative is the use of automated volume-based packaging with individual pricing of consumer packages.

11.4.2 Portioning / packaging lines, Option 2 (Fig. 11.2)

Permutation-type weighing devices are used in this case, with automatic random packing of blocks and consumer fillets. In order to ensure against excessive overweight, a check weigh-scale is installed in the line. Placement in freezer frames is automatic.

As an alternative, the block packages may be "further processed" into consumer packages as in Option 1, and in this case, block packages of fresh fish is the only format required.

(64) 11.4.3 Portioning / packaging lines, Option 3 (Fig 11.3)

This system is based on single-freezing of the individual fillet pieces permutation-type portioning machines, wrapping (packaging) machines, and crating machines.

11.5 Summary remarks regarding the filleting room

A large emphasis should be placed on making the working conditions as food as possible in this division of the plant. It should also be appraised carefully whether the rather rigid control systems used in many plants are indeed necessary. It is possible that a number of controllers (inspectors) may be profitably replaced by instructors / physiotherapists since it is apparent that this division very often is characterized by absurd working postures.

One of the ways to improve this is to create work stations that are as ergonomically well-designed as possible. The height of the work table must be easily adjustable. The opportunity must exist to change between a sitting and standing work position, and the flooring must be cushioned when the standing position is used. The height of the chairs must also be adjustable and there must not be so much equipment under the work table that there is no room for knees and foot-rests.

Fig. 11.4 is a sketch of one such work station used for clean-cutting / sub-division. It is based on the scheme whereby fillets

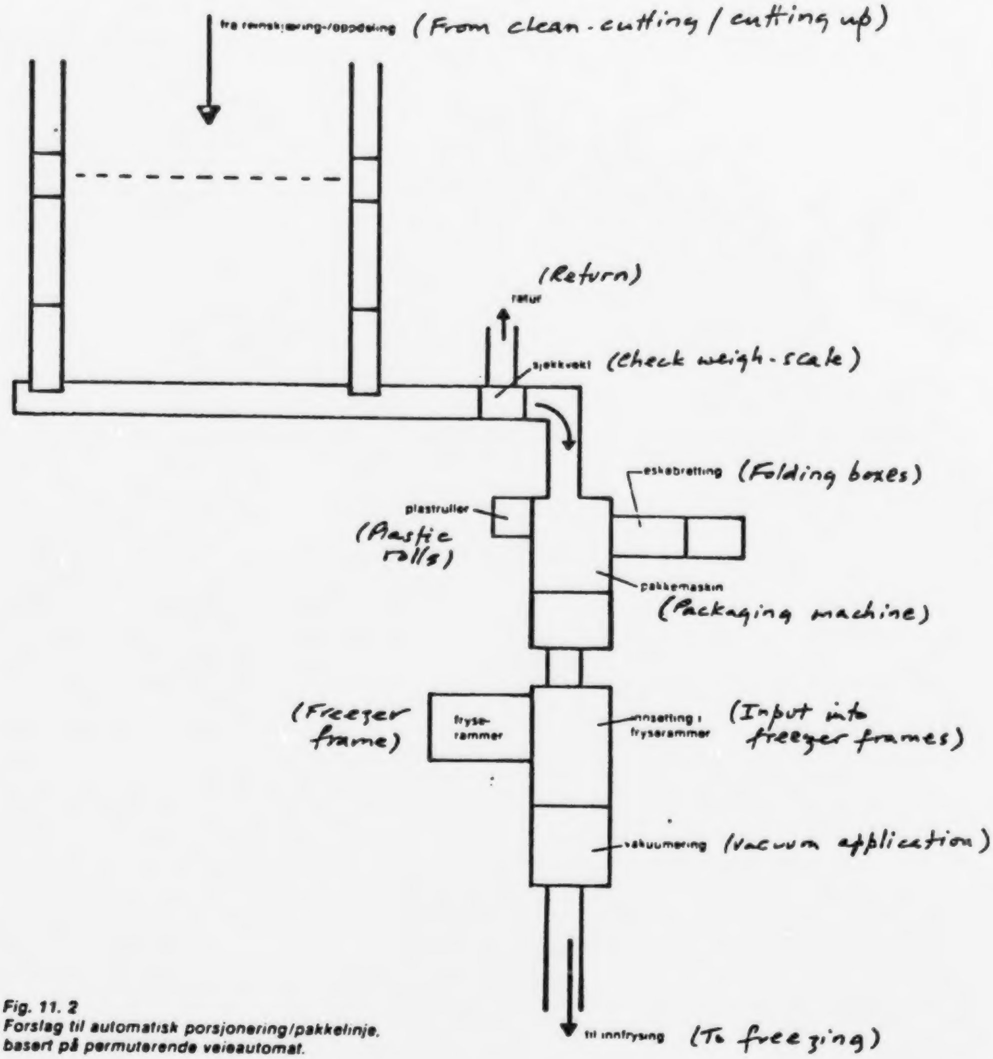

fra reinskjæring/oppdeling (From clean-cutting / cutting up)
retur (Return)
sjekkvekt (Check weigh-scale)
eskebretting (Folding boxes)
plastruller (Plastic rolls)
pakkemaskin (Packaging machine)
(Freezer frame) fryserammer
innsetting i fryserammer (Input into freezer frames)
vakuumering (vacuum application)
til innfrysing (To freezing)

Fig. 11. 2
Forslag til automatisk porsjonering/pakkelinje, basert på permuterende veieautomat.

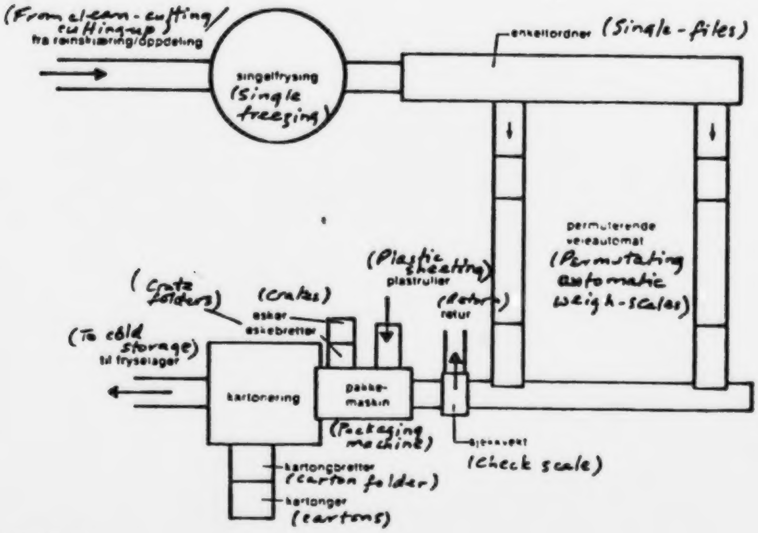
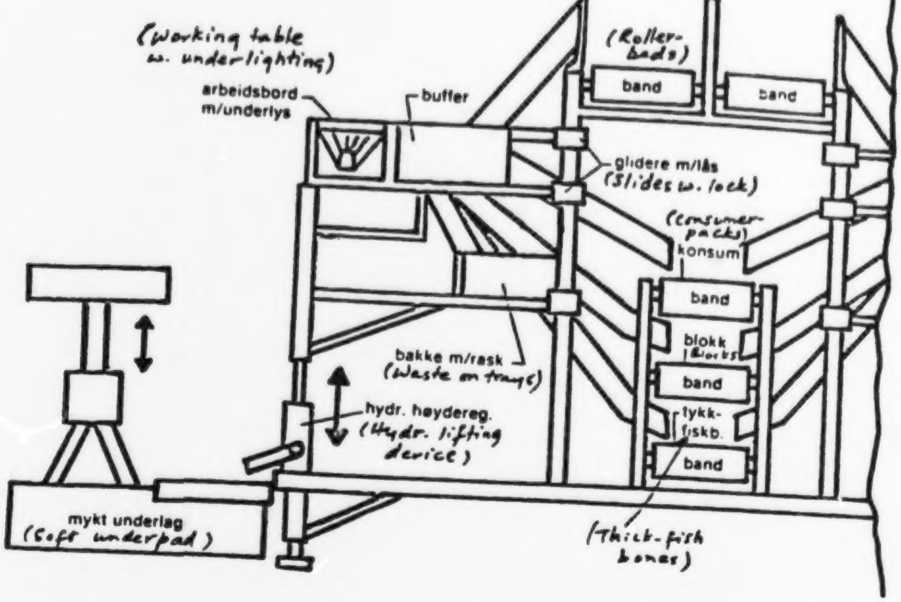
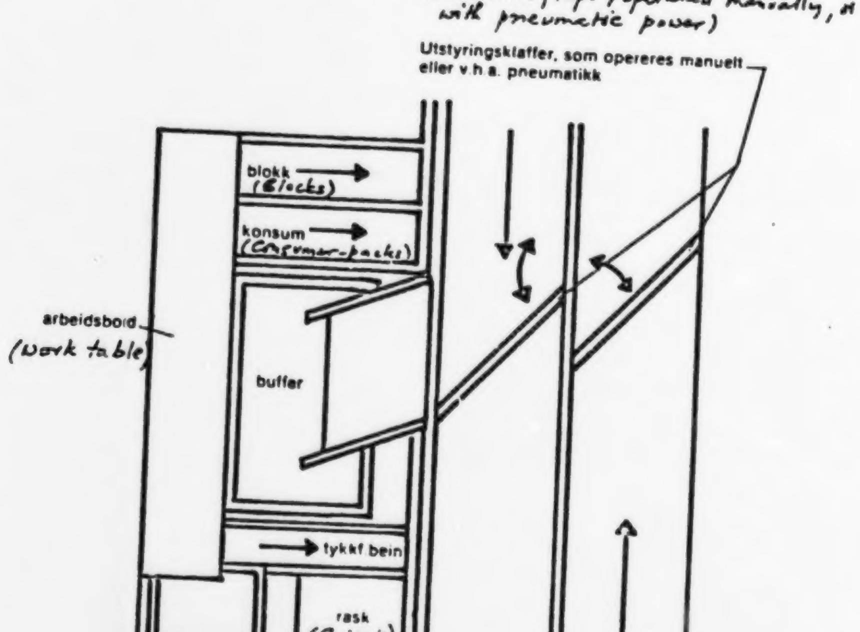

(From clean-cutting/ cutting-up) fra reinskjæring/oppdeling
singelfrysing (Single freezing)
enkeltordner (Single-files)
permuterende veieautomat (Permutating automatic weigh-scales)
(Plastic sheeting) plastruller
(Return) retur
(Crate folders)
(Crates) esker
eskebretter
(To cold storage) til fryselager
kartonering
pakkemaskin (Packaging machine)
sjekkvekt (Check scale)
kartongbretter (Carton folder)
kartonger (cartons)

Fig. 11. 3
Forslag til automatisk porsjonering pakke-linje, basert på singelfrysing, permuterende veiing, pakkemaskin og kartoneringsmaskin

Figure 11.3 Proposal for an automatic portioning/packaging line, based on single-freezing, permutating weighing system, wrapping machines, and crating machines.




(Controlled flaps, operated manually, or with pneumatic power)
Utstyringsklaffer, som opereres manuelt eller v.h.a. pneumatikk
blokk
(Blocks)
konsum
(Consumer-packs)
arbeidsbord
(work table)
buffer
tykkf bein
rask
(Reject)

Ved enden av linja blir filetene styrt over på det andre bandet.
(At the end of each line, the fillets are steered over to the 'other' belt)

Fig. 11. 4
Kombinert reinskjærings-/oppdelingslinje hvor enkeltfiletene kommer inn på band, og de ferdige stykkene går ut på band

Figure 11.4 Combined clean-cutting/cutting-up line in which individual fillets are input via conveyor belt, and the finished pieces go ouy via conveyor belt.

and fillet pieces are transported by conveyor belt. A system involving trays on conveyor belts is roughly identical in appearance.

It is important that factors are avoided which have an unduly stressful effect on the operators, such as individual contracts, group contracts, and machines which demand an elevated work tempo from the operators upstream or downstream of these machines. In cases involving highly specialized, heavy, or boring jobs, some system of job-rotation should be instituted.

If multi-function tables are deemed desirable, for instance in order to provide a varied work assignment, one proposal is shown in Fig. 11.5. The table has 4 operators who toghether wash off, cut up (sub-divide), weigh, package, and place the packages in freezer frames. Teams of two operators each work together to fill up the freezer frames.

Manipulating of the trays and frames is done using push-buttons.

A general need in any production arrangement is that it operates in an optimal fashion with regard to given framework criteria. Factors which figure prominently in the assessment are: working environment, production capacity / material flow, production elasticity, and economic considerations. On the basis of these factors, it is clear that the optimal arrangement represents a difficult goal to reach. Everyone involved can contribute, if they wish, to bringing this goal closer to reality.

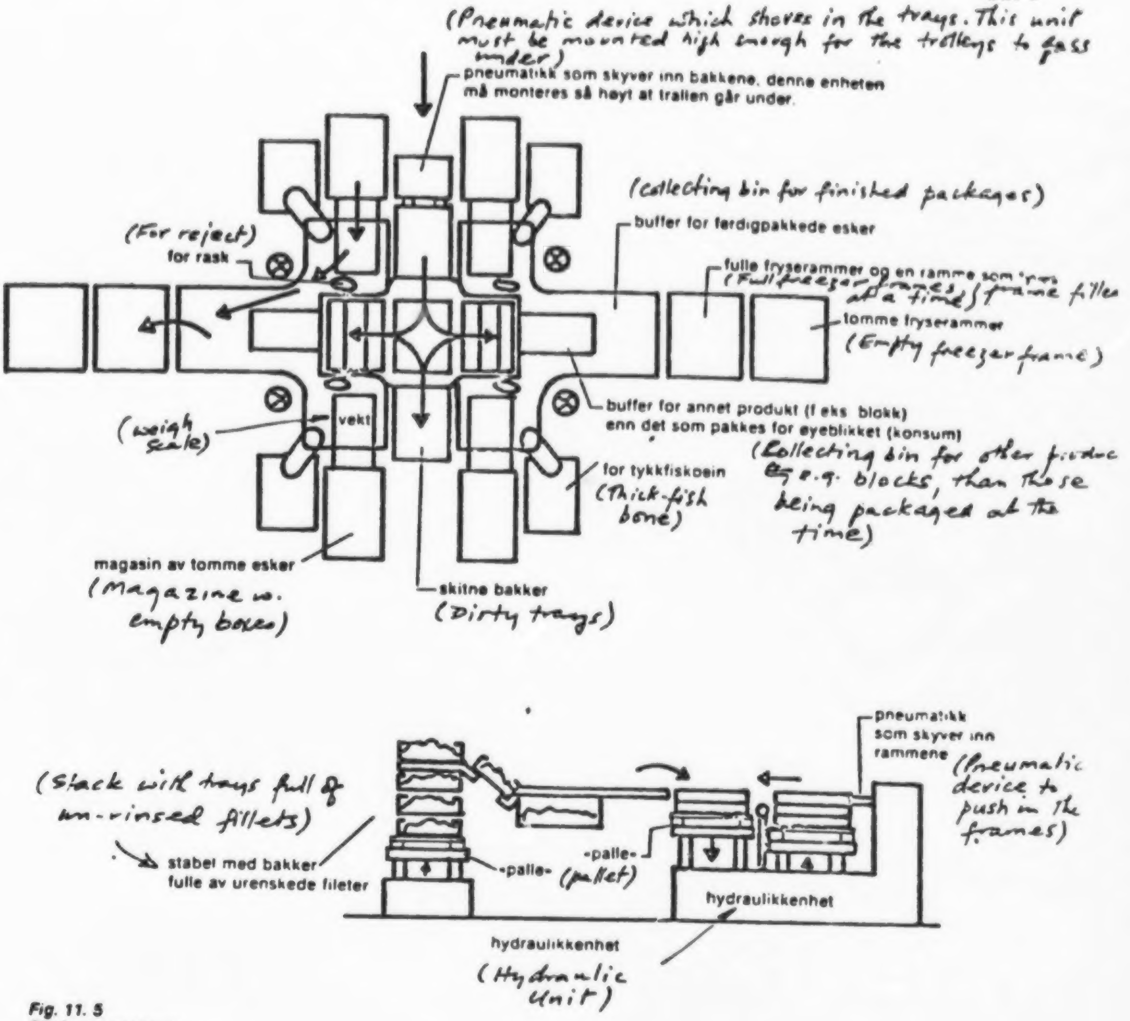

(Pneumatic device which shoves in the trays. This unit must be mounted high enough for the trolleys to pass under)
pneumatikk som skyver inn bakkene. denne enheten må monteres så høyt at trallen går under.
(For reject)
for rask
(collecting bin for finished packages)
buffer for ferdigpakkede esker
fulle fryserammer og en ramme som fylles
(Full freezer frames) frame filled at a time)
tomme fryserammer
(Empty freezer frame)
buffer for annet produkt (f eks blokk) enn det som pakkes for øyeblikket (konsum)
(Collecting bin for other produc ~~Eg~~ e.g. blocks, than those being packaged at the time)
(weigh scale)
vekt
for tykkfiskbein
(Thick-fish bone)
magasin av tomme esker
(Magazine w. empty boxes)
skitne bakker
(Dirty trays)
pneumatikk som skyver inn rammene
(Pneumatic device to push in the frames)
(Stack with trays full of un-rinsed fillets)
stabel med bakker fulle av urenskede fileter
-palle-
(pallet)
-palle-
hydraulikkenhet
hydraulikkenhet
(Hydraulic Unit)

Fig. 11. 5
Flerfunksjonsbord

Figure 11.5 Multi-function table.

(69)

12. FREEZING SECTION, WITH COLD STORAGE

This division can consist of the following units:

- Refrigerated interim storage prior to freezing, including transport equipment
- Freezer unit (freezer locker)
- Equipment for removal of freezer components (trays, frames) including transport equipment and equipment for cleaning the freezer components
- Equipment for crating and placing crates onto pallets

12.1 Refrigerated interim storage prior to freezing

Because freezing is a batch operation, there will always be quantities of finished, wrapped goods waiting to be frozen. These often remain sitting in the filleting room for 1 - 2 hours in temperatures raaching 20°C or more. Using the arguments for a refrigerated interim storage space (Chap. 10), the need can also be demonstrated for such a cold storage space prior to freezing. This storage space should therefore be the same as the one used as refrigerted interim storage between the cutting and filleting room, for fish-pulp raw materials and for other interim storage.

The finished, packaged goods can be stored in 2 - 3 different ways. Ths most accessible approach is to load the finished goods onto a shelved cart in the filleting room. The cart is then pushed into the storage space where both goods and cart stay until the goods are taken to be frozen (first in - first out principle). The cart is pushed to the freezer locker where the goods are to be frozen and the goods are transferred from the cart to the locker. A more line-dependent and "inflexible" arrangement is to use a roller-bed or conveyor-belt fed storage space which can be automatically run, to a greater or lesser degree. Transport to and from the storage space will then take place using conveyor belts or roller-beds. Whether the packages are transported and stored individually or in frames or trays, is determined by the format in which freezing is to occur.

12.2 Freezing

Freezing is carried out in horizontal freezer chests (lockers) where the freezer coils are arranged in horizontal plates in the locker space. During the freezing process, the freezer coil plates move together to put the goods under pressure, using an hydraulic device. The pressure of the freezer coil plates against the goods (both from above and below) results in the packages receiving an even, finished outer furface and also in a rapid freezing (contact freezing). The packages are held in a stable fashion in the frames which are set up in trays. The frames ensure that the packages maintain their shape and also limit external pressure on them. In each plate there are usually 4 trays, each holding 1 or 2 frames. Each tray holds approximately 20 kg and since there are 10 - 11 plates in the locker, each locker thus holds about 800 kg. The upper limit for each locker is about 1000 kg per freezing operation. The freezing time is about 1.5 hours, so in other words, each locker has a freezing capacity of about 3 tonnes per shift.

When the freezing is complete, the core temperature of the goods should be -20^{0}C or less. From a goods durability point of view this is very important in storage. "Ultimate freezing" in the storage room takes a long time.

(70) The tradition horizontal plate-freezers are served in the following manner. When a batch of goods standing in the locker is completely frozen (finished), the freezing process is halted. The freezer coil plates then are moved apart. The goods can then be unloaded from the locker and transported away on pallets or trolley-carts, etc. After this, a new batch of goods can be loaded into the locker. The freezer-coil plates then squeeze the foods under pressure, and freezing begins again.

The goods to be frozen are transported on special trolley-carts.

Often the freezer-coil plates are subjected to a rapid warming, using hot gases (defrosting). This results in the trays and goods being more readily loosened from the plates.

Work related to loading and unloading of freezer lockers takes place in a rather unpleasant working position. There is much bending over and lifting with the upper body turned to one side. In addition, low temperatures and drafts close to the lockers (cold-air down-flows) are a problem.

Equipment should therefore be developed for mechanical loading and unloading at horizontal freezer lockers. Such equipment is seen as being important from a work-environment point of view. It can also lead to more efficient work and thus higher freezing capacity. However, this latter benefit would not be so great.

12.3 Equipment for removal and washing of freezer components

In using such equipment, the freezer frames and trays are removed. Often a tray is removed during unloading from the freezer lockers. In some installations, the tray is also taken out during the loading process, in that both tray and frame (with goods inside) are set inside the locker and afterward the tray is jerked out. This results in shorter freezing times. In most installations, there is a pneumatic system for pushing out (ejecting) the frozen goods from the frames Such systems have a noise-level that is not really acceptable. Furthermore, the capacity is limited by the input speed of the operator.

A device should be developed that is less noisy and which, in addition, would contribute toward good material flow of goods and freezer components.

Cleaning of the freezer components must be done at regular intervals. It must be clarified whether it is necessary to conduct a cleaning each time the equipment has been used, or whether the equipment can be used several times between cleanings.

Between the various operations, the freezer components should be moved around by conveyor belt or roller-bed. Transport of equipment to an from the buffer area(storage space) can be done as mentioned above, or by means of trolley carts, for example. Transport via overhead track-ways under the ceiling is also a possibility.

12.4 Freezer system

I outlined above the possibility that the traditional method of freezing can easily be replaced by freezing on conveyor belts, i.e. single (individual) freezing, but this will not be discussed further here. Rather, I will discuss possibilities for using vertical plate freezers for freezing fillets in consumer or block packaging formats. The possibility of developing practical equipment for this naturally also exists.

The options which will be discussed here are all based on horizontal plate-freezers.

12.4.1 Freezing system, Option 1 (Fig 12.1)

The system operates in the following manner. Trays / frames holding finished goods are placed in cart-loaders and these hold a complete locker load. From the cart-loader, the trays / frames are transferred to a cart. The cart is then driven to the refrigerated interim storage space.

(71) When the goods are ready to be taken in for freezing, the cart is pushed to the freezer locker. The cart, which has shelves at similar elevations to those of the locker, is coupled to the locker. An extruding unit is also attached, and the trays / frames are pushed mechanically into the locker. At the same time, trays / frames with already frozen goods are pushed out on the other side onto another cart. Two sets of wagons are used to load / empty a locker.

When the locker is emptied and filled, the carts with fozen goods are pushed over to an unloading station. Here the goods are unloaded mechanically and are passed on to a unit where any adhering

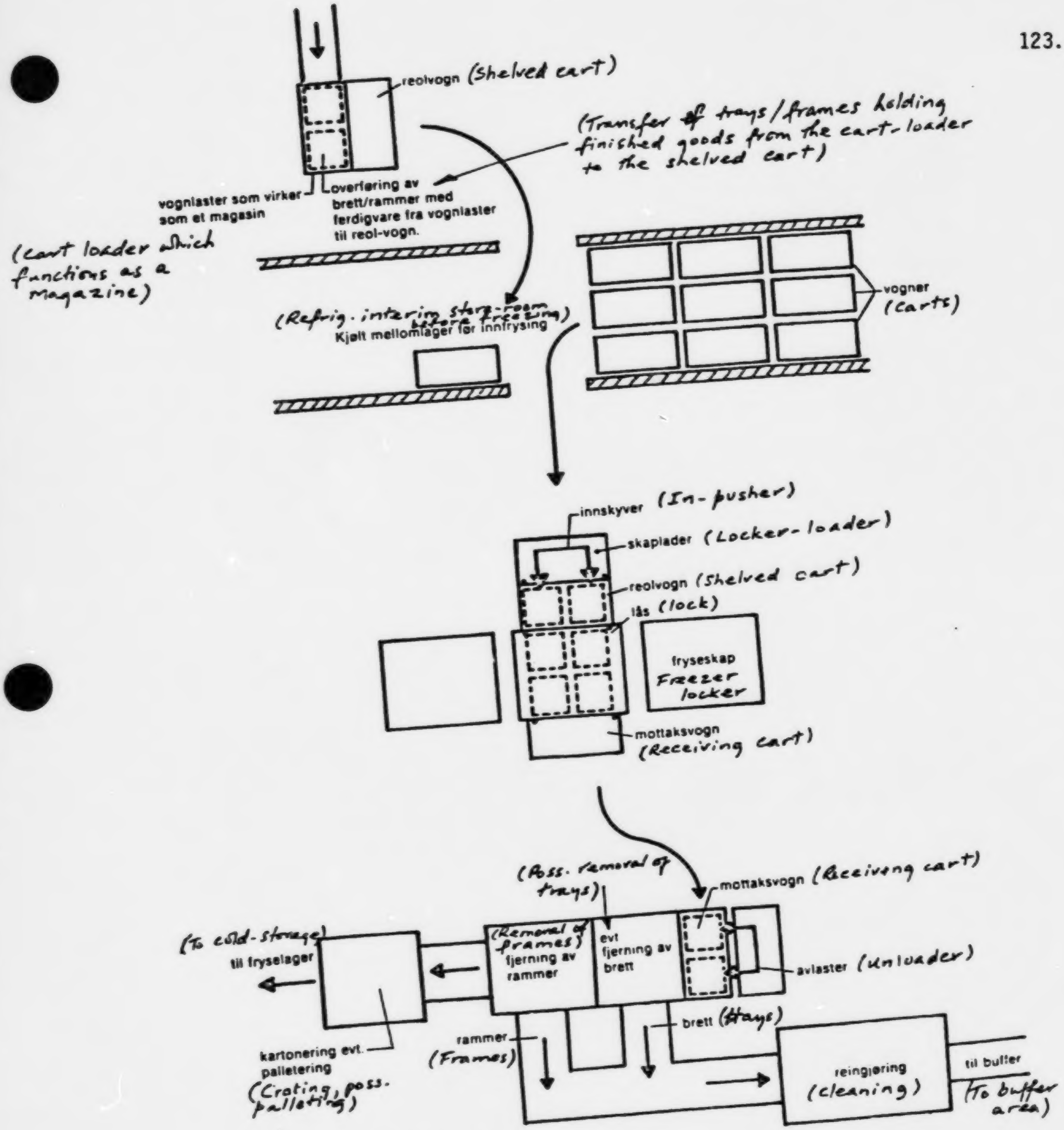

reolvogn (Shelved cart)
(Transfer of trays/frames holding finished goods from the cart-loader to the shelved cart)
vognlaster som virker som et magasin
overføring av brett/rammer med ferdigvare fra vognlaster til reol-vogn.
(cart loader which functions as a magazine)
(Refrig. interim storage-room before freezing)
Kjølt mellomlager før innfrysing
vogner (Carts)
innskyver (In-pusher)
skaplader (Locker-loader)
reolvogn (Shelved cart)
lås (lock)
fryseskap Freezer locker
mottaksvogn (Receiving cart)
(Poss. removal of trays)
mottaksvogn (Receiving cart)
(To cold-storage)
til fryselager
(Removal of frames) fjerning av rammer
evt fjerning av brett
avlaster (Unloader)
rammer (Frames)
brett (trays)
kartonering evt. palletering (Crating, poss. palleting)
reingjøring (cleaning)
til buffer (To buffer area)

Fig. 12. 1
System for automatisk inn-/ut-lasting ved horisontale fryseskap, basert på reolvogn og skaplader.

Figure 12.1 System for automatic in- and out-loading to and from horizontal freezer lockers, based on shelved carts and locker-loaders.

trays are removed, and the frames go on to an ejection unit where the goods are pushed out.

Trays and whatever frames are present are passed on through a cleaning station (disinfection station) and to a buffer (collection) area. The packages with frozen goods are then crated (consumer packages) or placed onto pallets (block packages). This can be done either mechanically or manually. It is likely that relatively large quantities would have to be involved in order for mechanical palleting to be profitable.

12.4.2 Freezing system, Option 2

In this case, the same type of cart-loader and carts are used as described above. However, the loading process is different in this system. The locker operates in the same way that those lockers used for freezing of ice-cream, i.e. the plate loads "work" up and down, whicle loading is carried out at one level. In this system, however, the cart must be raised immediately after the batch is pushed in. Both trays, frames, and equipment as shown in section 12.4.1 are used.

12.4.3 Freezing system, Option 3 (Fig. 12.2)

In general this system is identical to the systems used for freezing of ice-cream. The packages are transported on conveyor belts from the packing stations to the refrigerated interim storage space. From the interim storage, the packages are driven on conveyor belts to the freezer locker in which they will be inserted.

For each "batch" of packages that is inserted, one already

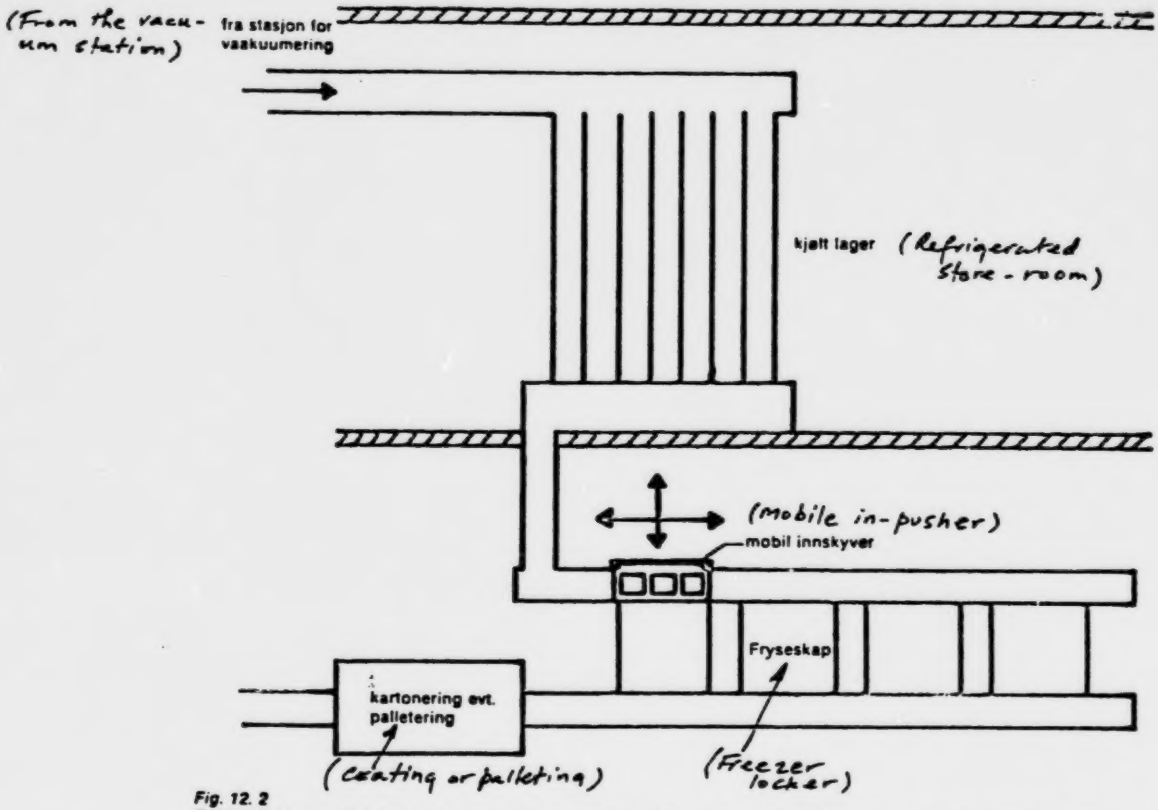

(From the vacuum station)
fra stasjon for vaakuumering
kjølt lager
(Refrigerated Store-room)
(Mobile in-pusher)
mobil innskyver
Fryseskap
kartonering evt. palletering
(Crating or palleting)
(Freezer locker)

Fig. 12. 2
System for automatisk inn-/ut-lasting ved horisontale fryseskap, basert på båndsystem for transport til/fra og stasjonære inn-/utlastingsstasjoner for hvert skap.

Figure 12.2 System for automatic in- and out-loading to and from a horizontal freezer locker, based on conveyor belt system for transport to and from, as well as stationary in- and out-loading stations for each locker.

frozen batch is pushed out on the other side of the locker. This latter goes by conveyor belt for crating or for placement onto pallets. The arrangement must be sufficiently flexible for use with various package sizes. A similar system is conceivable for use with packages held in frames / trays.

Also conceivable is a system in which carts or possibly a shelving system holding the goods are placed into the lockers during freezing.

In general, there will be a benefit if trays, or possibly, frames could be cleaned together with the above-mentioned, or other, loading / unloading systems. Benefits will be in the form of increased freezing capacity, smaller equipment costs, and less handling.

12.5 The freezer storage room (cold storage room)

Most cold storage rooms used in the fish processing industry have an interior height of 5 - 8 m, and this rules out the possibility of vertical stacking in the room. Neither are shelving systems, or the like, a viable option. In future, there should be stacking cold storage rooms in use in order to make the best possible use of the basic floor area. In order to be able to make full use of the room height, there will be real benefits in using shelves, etc. (depth-stacking storage
(72) room). This will also ensure against collapse of stacks, as well as lead to improved order and supervision. Computers can also be used to maintain track of the contents of the storage room. The storage room must be convenient to load and unload. It must be equipped with a door-system which ensures the minimum cold-air loss and temperature variation

(drying out of goods that are improperly packaged).

(74) 13. CONVENTIONAL PRODUCTION IN FILLETING INSTALLATIONS (BY-PRODUCTS)

By-products such as fish-pulp and animal feed were discussed previously and so are not included here. Traditional by-products refer to salt-fish, dried fish, and, to a certain extent, salted fillets (fillets with skin and smaller bones intact). Production of dried fish and salt-fish are often referred to as conventional production.

Some plants sell a certain amount of product variants such as frozen fish cutlets, and the like.

The market for salt-fish and dried fish has traditionally been highly variable and uncertain. In recent times, we have undergone a crisis in the dried fish industry because of the collapse of the Nigerian market. Nowadays, a large amount of dried fish is being sold to Nigeria and the situation is looking brighter.

In the filleting plant one often has fish which are unsuitable for fillets (because of quality, e.g. poor quality fish caught in nets or size) but which are used for salt - / dried-fish. These two product types are also produced if the plant takes delivery of large quantities, in excess of the needs for fillet production, and for which re-sale or double-freezing is not possible.

Usually, there are often fish over 60 cm in length which are used for salt-fish. What a plant eventually produces is obviously determined most by market availability and price. It should not be that salt- and dried-fish production are only used as "dumping production" for fish of poor quality. Ordinarily, the worst raw material go into dried-fish production. Because of the "worm problem" fish are not hung in areas north of Lofoten in the months of June, July, and August.

In the future, it will also be desirable, mostly because of flexibility considerations, that by-production of salt- and dried fish be continued. This is on condition that satisfactory markets exist, and that these markets are not covered by the traditional plants (plants that do not produce fillets). There are also other types of by-products that are conceivable, such as dried heads and backs.

There is a great need for the development of equipment for a more rational and production-line suitable arrangement insofar as salt-fish and dried-fish are concerned.

It is perhaps not very conceivable that filleting plants in general will begin to get into the production of klippfisk (dried, salted cod). If a surplus of raw material arises, then salting of this surplus for further processing into klippfisk can be envisaged, providing that a market for such a product exists. Salted fish used for klippfisk production is not always of first-class quality. For klippfisk production to become a real possibility, then one must become critical in the procurement of curing facilities. Careful assessment must be made of the siting, management, energy consumption, maintenance, and so on.

We can conclude with the statement that by-production can serve to increase the flexibility of individual plants in making use of available raw materials, as well as in making the plant less sensitive to market swings of individual products.

(75)

13.1 Dried fish production

The production flow after cleaning, head removal, and washing consists broadly of the following:

- Opening the fish up (spreading)
- Washing
- Transport to the drying plates, or rock slabs
- Transport to the dried fish storage room / drying loft
- Storage in a place where after-drying can take place (dried fish will weigh about 22 - 25% of the cleaned, headless weight)
- Sorting, criteria are size and quality
- Bundling (approx. 45 kg per bundle)
- Storage
- Quality control check, which occurs at the time of shipping, conducted by the Fresh Fish Control Office
- The bundles are packed into jute sacks labelled beforehand
- Sealing the sacks by sewing
- Shipping

13.1.1 Views regarding the dried fish production of the future

Fish destined for dried fish production must be size-sorted prior to being spread and hung, so that they are hung on the drying plates in size groupings. This taking down and transport also are done according to size groups, and thus, bundling is dependent only on quality and is therefore made simpler.

Opening-up (spreading) machines will constitute an important supplement to the dried fish production methods of the future. Spreading machine(s) will be available on the market in the future but whether these will be adequate for the job must be investigated very closely.

The traditional drying plates should be replaced by something else. It is possible, among others, that system~~s~~ consisting of "magazines" would be used. Immediately after the fish is spread, it is mounted onto magazines, which are then transported over to the drying facility and placed into the plate system. An initial approach to this can be that the fish are nounted onto special racks or possibly steel wires after
(76) spreading. These are tranported to the drying plates and hung.

The problem of birds at the plates has always existed. Two traitional methods are conceivable for solving this problem:

- Protection in the form of netting, made either of nylon or thin metal wire. When the netting is not in use, it could be rolled up on rolls or possibly stored someqhere.
- Frightening them off using movements or noise. Noise-makers or moving objects should be made to operate at random (stochastically) so that the birds do not come to recognize a pattern in their function. One possibility is a programmed robot having a set of motions and noises on file. The choice of the type of noises and movements that occur will then occur at random.

Taking the material down from the plates can be done by taking down the magazines, or racks or strings as the case may be, or or single fish. The main principle is that size-groupings are kept separate.

Transport to the drying loft can occur in nets. The stacking itself would probably still be done manually for quite some time in the future. The drying loft can easily be equipped with air-conditioning to maintain the proper temperature and humidity.

During the sorting process, the various size groups of fish are sorted according to quality. Either belts of chutes, or other means, might be used to take the fish from the sorting table to the bundling machine. During sorting, the various quality fish are placed each in its own magazine. From each magazine the fish are then taken out for bundling, and the sacks are placed in storage. This process can be carried out as mechanically or in as automated a fashion as desired.

Some complaints have been registered over the existing bundling machines, and so it is should be investigated whether improvements are possible.

Investigations should also be made into whether it would be possible to use crimped plastic bags instead of jute sacks, as the packaging material. The plastic must be such that air can pass through it. If jute sacks are retained, a system should be set up for mechanical stuffing of the bundles into the sacks.

Quality control of the goods prior to shipping results in an extra amount of handling. With the use of jute sacks it is necessary to hold the sewing up process until the control check is finished, and possibly the entire process must be held up for that step.

Mechanical equipment for the sewing and labelling process ought to be developed.

If plastic sacks are eventually used the packaging must be done after the control check step.

Dried fish which is randomly scored (cut on surface) has a much better sale potential than ordinary dried fish. Randomly scored (rotskaret) fish are fish that have been split as far back as the tail, but still holdstogether firmly enough for the split fish to be hung over a rack (rod). The part of the back-bone anterior to the anal aperture is cut away. Investigations should be made regarding the possibility of developing a machine for such a cutting operation, perhaps
(77) in the form a further development to the current splitting machines.

13.2 Salt-fish production

Production of salt-fish, after cleaning and head removal, takes place in the following manner:

- "Kverking", i.e. for fish with roe, the throat area must be cut upward following the cleaning (gutting) process. This is because of the special cut used in the cleaning process or fish with roe in order to save the roe and protect the ear-bones.
- Splitting, which can be done by machine. During this process, the fish is split upward from the abdomen and the anterior part (to 3 joints posterior to the anal aperture) of the back-bone is removed.
- Washing.
- Salting, either in approx. 1 m high stacks, or in vats. The fish stand in the salt brine for about 4 - 5 days.
- Re-salting, i.e. the fish are removed from the first bath and salted again in stacks of 1 m, using new salt. The fish remain for 2 - 4 weeks

in this bath and are salt cured. The time this requires varies according to the size of the fish.

- After salt-curing, the fish are taken out of the stacks and sorted according to size and quality. In additon, spoiled portions are cut away.
- The fish are placed in stacks for storing, which can take place on pallets. The palleted units are then ready for shipping.
- In the case of overseas sales of salt-fish, graders from the Fresh Fish Control Office arrive to take spot samples of the consignment. It is also possible that a representative of the buyer can be on hand. For domestic sales, only the buyer's grader might be present.
- Shipping takes place by either boat or motor vehicle in summer, but if the consignment is to be shipped far south, a refrigerated space is used during the transport. For domestic transports, it is not necessary to package (enclose) the pallet units and they are usually labelled with a slip tucked between 2 fish. In overseas transport the consignment must be either packaged or bound, and proper labelling is necessary. Pallet covers or crimped plastic sheets may be used for packaging.

13.2.1 Views concerning salt-fish production in the future

We have seen above how salt-curing is dependent on fish size. During the grading process as well, a size-sorting takes place. In order to obtain a more rational processing, the size-sorting must take place prior to splitting. This can be done either manually or (78) mechanically. In this way, the salt-curing process would be made easier, since there would then be only fish of one certain size in each stack. In addition, grading would be also easier.

Equipment should be developed for mechanical "kverking", since this is a relatively time-consuming process manually. Investigations must be made into whether the filleting machine can be retrofitted with a unit for this job. Another possibility is the development of a machine that can be installed upstream of the splitting machine.

Most of the smaller plants do not have splitting machines, as splitting is done by hand. There is definitely a need for a more production-line-oriented arragement for manual splitting. It is also important that the work stations be properly designed, from an ergonomic point of view.

The washing systems currently in use are too hard on the fish and objections have also been raised regarding the washing quality. The need therefore exists for a washing system which washes the fish properly and which at the same time is gentle. During the winter 1978 - 79, a washing system based on conveyor belts and water spraying was developed. Preliminary tests are encouraging.

As mentioned previously, the cutting away of spoiled portions of the fish takes place after salt-curing. However, this process can be beneficially carried out after the washing step since the fish are easier to cut in the fresh, rather than the salted,state. At the same time, entrail remains, etc., could be rinsed off.

Recently it has become more and more common for the fish to be salted initially in vats (tubs). The advantages of this are:

- Flexible transport systems, since the salting can be done right after washing, or rinsing as the case may be.
- Less demand on space, since the vats can be stacked one upon the other.
- All parts of the fish are exposed to the salt because of immersion in the brine-bath.
- The fish meat takes on a white colour since the blood is drawn out

The last two points would also lead to an increase in quality parameters.

The problem with salting in vats involves the blood that becomes mixed into the brine. For this reason, care must be taken not to keep the fish too long in the vats (rancidity).

In order to obtain a pleasant work posture (and thus lessened bodily wear and tear), as well as higher salting capacities in the vats, vats with a moveable bottom plate should be used. This bottom plate would be hung from a block and tackle, and immediately after fish is placed to salt on this bottom plate, it would lower itself so that the operator would always be loading the same working height above the floor. The lowering could be done manually or automatically. The fish must be brought to the salting facility at a proper working height. There is a need for the development (if such cannot be found) of a device which would sprinkle salt between the fish layers. This is important insofar as the quality of the fish is concerned, as well as enabling higher capacities in the salting process.

(79) Re-stacking should be done on long flat slabs which then can be lifted up by an elevating system, and unloaded, in order to save space. Pallets and shelving systems are currently used in some plants, but the main problem of such shelving systems is corrosion. In addition, permission must be applied for to re-stack onto pallets. A system for metering salt quantities and for salt sprinkling will also have definite advantages during the re-salting process.

Following salt-curing and sorting, the fish can be stacked onto pallets which are then placed onto a shelving system to await shipping. A rational and production-line adaptable arrangement should be used for this, especially one having a lifting table. This latter suggestion would also apply to the re-salting step.

For packing, one could use crimped plastic sheets, dispensed by machine (if desired) and which are subjected to low heat. This would obviate the need for severe crimping since the main objective is not the security of the pallet load. Special equipment for labelling should also be made available.

(81) 14. EXPANSION, PRODUCTION-ORIENTED AND TECHNICAL DEVELOPMENTS

4.1 Overall plan

The potential for a more rational production is always present if one makes plans for further advances, structural changes, or new layouts of the production-related apparatus.

The point of departure for a readjustment in production approaches must therefore be a systematic appraisal of the existing situation. The evaluation should extend to the use made of the plant site, the placement of the various plant components with respect to each other, and the production flow-pattern from receiving of the raw material to transport loading of the finished products. Critical evaluation must also be made on a regular basis regarding whether the production complex is up to date in terms of the technological developments taking place. The following conditions can be taken as examples of reasons for such an analysis of the production picture.

- The production volume is increasing and increases in production capacity are necessary
- New products and production methods are going to be fitted into the production apparatus
- Increased exploitation of the raw material and a better (quality-wise) production process is necessary
- The production is not sufficiently rational and increased productivity is necessary
- Environmental improvements and ergonomically better working stations are necessary in order for the plant to become abreast of industrial developments, or to obtain and keep well-qualified man-power.

When one is planning a re-structuring, it is necessary to think through the production-related developments which are expected in the near future. This includes growth patterns, new products, and new production equipment that space must be made for. It also includes initiatives aimed at ensuring environmental responsibility.

In earlier times, it was common to "tailor-make" factory plans around the planned machinery. This principle has now been abandoned since there always appear new requirements which one could not have foreseen in the planning stage.

It is therefore necessary to make an overall, or general, plan which has built-in a large degree of flexibility. This flexibility means that the general plan would allow space for new buildings and expansion of existing buildings without this being at the expense of a rational production scheme.

14.2 Planning on the details level

Before one can begin the concrete planning stage, one should carry out the following simple preparations:

- Draw up a raw-materials prognosis for the next few years
- Draw up a general production plan for each month of the year
- Define the capacity needs for each month of the year
- Take stock of the rationalization opportunities currently available through simplification and mechanization, as well as through improved production and transport equipment
- Evaluate how optimal use can be made of raw materials, manpower, production capacity, and investments

Docks, buildings, and production equipment represent considerable investment. It is therefore important that the plans be thoroughly worked out.

The factory plans should be drawn up to a scale of 1:100 or 1:150 with all components, transport pathways, and production lines indicated, preferably with several alternative arrangements.

It is also important that one get a hold of as much outside suggestions as possible which can contribute to an effective plant complex. Good sources for this are industrial architects, technical consultants, research institutes, trade organizations, and industrial consultants.

Inside the operation, the plans should be discussed at all levels, from the manager down to that of the "users", i.e. the production employees. Experience has shown that many good suggestions can be had from this source.

After the alternatives have been weighed against each other, consensus must be reached on one plan. A viable and rational plan should satisfy the following production-technical requirements:

- Make possible an increase in high-value finished product at the expense of waste and animal feed
- Make possible a flexible volume handling capability, an evening out of employment requirements, and capability of handling peaks in production when raw material supplies are large
- Ease of re-arrangement to accomodate other products and output formats

- Possibility for concurrently producing a variety of product variants in different volume-mixes
- Smooth production flow and built-in buffer (collection areas) in the system in order to avoid unneccessary emergency operations in the production line
- Simple or dependable technical solutions, in order to prevent costly production halts
- Design work stations in such a way that they are ergonomically correct. This involves avoiding unneccessary static muscular tension; encouraging proper work movements and work tempo; and unneccessary changing from standing to sitting work positions
- Proper temeprature and light levels. Easy access for maintenance and cleaning. Good screening to prevent messes and water splashing

14.3 Introduction of new production facilities

After the construction, mechanization, automation, and technical restructuring of the production scheme are complete, it is still necessary to bring the facility properly into production. This task involves:

- Discussion with staff regarding production goals
- Establishment of normal "shake-down" time
- Organization of "trouble-shooting"
- Ensuring that the planned production capacities are achieved as well as the specified staffing. Calculate new base data for collective (salary) agreements.

During the "shake-down" phase and after, the re-arrangement is completed, the following aspects are maintained:

- Production capacity achieved, both total as well as at the principal machines and production lines
- Savings and increases in efficiency
- Economic results assessed through accounting and technical / economic key figures or indexes
- Discussions with the production staff on whether the installation meets their expectation and requirements in terms of the working environment.

If the expected results are not achieved, it is necessary then to evaluate what adjustmens could be made to the production installation, and on whether the specified goals were in fact realistic.

REFERENCES

(1) FTFI - "Costs Associated With Cod-fish Processing". Work-notes, Project 664.1 - 4, no. 3.

(2) FTFI - "The Norwegian Fillet Industry - Possibilities for Improving of the Production Technology and the Physical Working Environment". Report no. 663.3 - 4 - 1.

Included in (2) is a list of all the literature which formed the basis for this report.

(3) Address by Production Chief Remme (Nestle-Findus, Hammerfest) during the OUF conference at Hammerfest, 26 - 27 / 10 / 78.